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Symposium on Diseases of the Colon

Introduction

PROGRESS in our knowledge and treatment of diseases of the colon has been slow. Littré, in 1710, proposed the first surgical procedure for relief of colonic obstruction which eventuated in Pillore's cecostomy (1776) and Duret's left iliac colostomy (1793). Excisional treatment began with Faget's posterior proctectomy (1739) to culminate in Miles' abdominoperineal resection (1887) based on pathological studies. The restoration of the gastrointestinal tract was almost solved by Lembert (1826), was abetted by the Murphy button (1892) and circumvented by the obstructive resection championed by Mikulicz (1903) and others. The Boston City Hospital was much interested in intestinal surgery at this time as evidenced by the work of Hayward W. Cushing (1886) on a continuous intestinal suture. After many false starts functional surgery was recently placed on a firm foundation by Swenson's classic work on congenital megacolon (1949).

Despite this long history many challenges remain. The treatment of cancer leaves much to be desired notwithstanding the widened boundaries of excision and the chemotherapeutic endeavers of various cancer centers.

Diverticulitis presents many problems—when to operate; how much to resect; how many stages; when to close a colostomy; is it cancer? Ulcerative colitis is dreaded. Ask three surgeons how to handle a case of rectal prolapse and you will probably get three answers. The common hemorrhoid deserves a better fate as it meets its end than it is usually accorded.

To bring us up to date on many of these problems, the following Symposium was presented by the Third (Boston University) Surgical Service in its Sixth Annual Seminar, devoted this year to diseases of the colon. Many thanks are due the participants for the time and effort spent in preparing these presentations for delivery and publication.

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Aganglionic Lesions of the Colon

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AGANGLIONIC lesions of the colon may be divided into congenital and acquired types. The congenital lesions have been closely associated with the name of the Danish physician, Hirschsprung, who published a classic description of two cases in 1888 [1]. In 1901 Tittel reported the absence of ganglion cells in the distal colon beyond the enlarged part [2]. However, the mechanism of the disturbed physiology was not completely understood until the absence of peristalsis in the aganglionic segment was reported by Swenson et al. in 1949 [3]. The idea of studying the distal segment was suggested when the symptoms of Hirschsprung's disease promptly recurred in three children after their colostomies were closed. Colostomies had been made previously because of symptoms of acute intestinal obstruction. Reopening the colostomies relieved the children completely. Recognizing that a localized aperistaltic segment of intestine acted as a physiologic obstruction, removal of this segment and restoration of bowel continuity was proposed. The pull-through anastomosis was designed to permit removal of the aganglionic segment and anastomosis of the proximal colon to the rectum adjacent to the anal canal [4].

The pathology is ordinarily limited to the colon. In the advanced form of the disease there are such generalized manifestations as enlargement of the abdomen and increased anteroposterior diameter of the chest, wasting of the muscles and subcutaneous tissues in the extremities, and anemia. In the megacolon proximal to the aganglionic lesion, the wall is thickened from chronic inflammation of the mucosa and submucosa, and hypertrophy of the muscularis. Stercoral ulcerations form in the mucosa where the fecal masses cause pressure necrosis. In the dilated part there is a normal distribution of the submucosal plexus of Meissner and the myenteric plexus of Auerbach. Grossly, a funnel-shaped deformity is found at the distal end of the dilated segment. Over a distance of 5 to 10 cm. the caliber and gross appearance of the colon become normal. Histologic studies reveal a sharp line of demarcation in which the ganglion cells in the submucosa and myenteric plexus completely disappear, and only nerve bundles may be found in the remainder of the intestine [5]. The aganglionic lesion extends from the distal end of the dilated segment through the narrow segment and includes the internal anal sphincter. In the majority of patients the lesion extends proximally only to the rectum and rectosigmoid colon. Occasionally the left colon or even the entire colon may be aganglionic. No cause for this anomaly has been found, but a malformation in the development of the pelvic parasympathetic system during fetal life is suspected.

The sex incidence is five to one, favoring males over females. A familial relationship has been noted only rarely in which multiple siblings or parents and offspring were affected. In our experience with over 200 patients, multiple cases occurred in only four families. Two brothers four years apart in age were treated in infancy. A set of identical twin brothers had the disease. A twenty-two year old woman underwent resection and later had a son with Hirschsprung's disease. A fourth family had at least three children with this condition and probably a fourth who died shortly after birth without autopsy. Congenital megacolon is one of the most common anomalies of the colon and the second most common cause of intestinal obstruction in the newborn, second only to atresias and stenoses of the small bowel [6].

The symptoms of this disease are chronic constipation with recurrent bouts of intestinal

obstruction. The newborn infant with this lesion has difficulty passing meconium and may present with symptoms of acute intestinal obstruction. However, if the lesion is limited to the rectosigmoid, colonic irrigation or vigorous anal dilatation may relieve the obstruction. The infant may then do well for varying periods. The infant and younger child are particularly prone to bouts of enteritis which may be so severe that the child may collapse and die within twenty-four hours from fluid and electrolyte losses. The mortality rate in the newborn has been reported as high as 70 per cent. Colostomy tends to protect the child from such bouts and also from developing a state of chronic enteritis accompanied by fever, distention, poor appetite and diarrhea. As the colon dilates and the sigmoid becomes more redundant it may twist on itself, and acute intestinal obstruction develops.

The diagnosis of an aganglionic lesion is ordinarily made by barium enema. The radiologist should be alerted to the suspected diagnosis so that he will instill only a small amount of barium mixture to outline the narrow or normal caliber aganglionic segment and the beginning of the dilated segment [*8*]. If the barium mixture is instilled in a routine fashion, the narrow segment may be obscured from view by the widely dilated, redundant sigmoid. Another characteristic of these patients is that they are unable to evacuate the barium, and a large instillation of the barium mixture may be difficult to remove subsequently.

Rectal biopsy is used as a supplemental diagnostic aid in those cases in which the radiologic diagnosis is insecure [*9*]. This diagnostic aid is particularly helpful in the management of the newborn infant when characteristic radiographic findings are not present and do not develop for several months. The specimen is obtained, with the patient under general anesthesia, by excising a small piece of the rectal wall just above the anal canal, taking care to obtain some of the muscular layers with Auerbach's plexus. The incision in the muscular coats and mucosa should be closed in layers to prevent infection.

The treatment of choice, if the patient is in good health, is local resection of the aganglionic segment [*10*]. The plane of dissection in the pelvis is on the rectal wall, taking care to avoid injury to the pelvic nerves supplying the bladder and genital apparatus as they stream through the perirectal fat. The dissection is continued to the pelvic floor and the rectum inverted out through the anus. Enough of the left colon is mobilized with a pulsating marginal artery so that it is of sufficient length to be pulled through the inverted rectum. A two-layer anastomosis is made on the perineum between the mobilized, descending colon and the inverted rectum. When the anastomosis is completed, it retracts into the pelvis and comes to lie 2 to 3 cm. above the mucocutaneous margin in the anal canal. Leaving this amount of aganglionic rectum and internal anal sphincter allows these patients to be continent and yet frees them from the symptoms of the megacolon.

Temporary colostomy is recommended for neonates and older patients with acute intestinal obstruction or those who are chronically ill with enteritis. An acute episode of enteritis is better managed with rectal irrigations and intravenous fluids, deferring the colostomy until the acute attack has subsided. The colostomy is placed in the distal end of the dilated segment, and the presence of ganglion cells is confirmed with biopsy at the time of operation. The colostomy is resected with the aganglionic segment when the infant weighs 25 pounds or when the patient's condition is improved enough to withstand major resection of the colon. Colostomy is indicated in the infant as soon as the diagnosis is made, even though the child may be doing fairly well, to prevent the occurrence of enteritis. Some infants become so ill from enteritis that they are unable to withstand even colostomy.

In the course of the past ten years, more than 200 patients with congenital aganglionic megacolon have undergone resection [*11*]. The mortality rate for resection of the aganglionic segment was 3 per cent, and severe complications were uncommon in this series. Following operation the symptoms of distention and constipation were relieved. The caliber of the colon returned to normal in many of the patients. In the group of patients followed up five to ten years after operation, all except one were relieved of their symptoms and had normally functioning colons. Rarely, the syndrome of chronic or recurrent enteritis may persist after resection, and anal sphincterotomy has been found useful to clear the enteritis. Incontinence has not been a problem in any of these patients, probably because the internal

anal sphincter is involved in the aganglionic defect.

Acquired aganglionic lesions of the colon are rarely seen in this part of the world but are a relatively common problem in some countries of South America [*12*]. MacMahon has seen three verified cases in Boston [*13*]. It now appears that certain cases previously considered chronic sigmoid volvulus of the aged may be acquired aganglionic megacolon. The lesion is found in older people in whom chronic constipation and abdominal distention develop. The x-ray finding of a megacolon proximal to a narrow aganglionic segment is diagnostic. The histologic picture in the bowel wall is one of degenerating or absent ganglion cells in Auerbach's plexus. The aganglionic segment is resected in these older people with relief of symptoms.

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DISCUSSION

John J. Byrne (Boston, Mass.): Are there any complications from these rectal biopsies?

Dr. Fisher: We have seen one patient who had some bleeding from the biopsy site; that was before we began closing it with a suture. Now we close the muscularis with silk and the mucosa with catgut.

Some Comments on the Surgical Treatment of Imperforate Anus

LONG TERM RESULTS AND POSTOPERATIVE MANAGEMENT

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IT is customary for most authors to use the classification of the different types of imperforate anus that was introduced by Ladd and Gross in 1934 [6]. The published results of treatment are based on this classification and a figure of 55 to 60 per cent over-all good results is usually quoted. However, it is difficult to find long term follow-up analyses, which are particularly important, because an assessment of the efficiency of rectal control in a child under the age of three years is certain to be inaccurate. Also, the criteria used in assessing rectal function are frequently not stated. Concealed among reported good results based on the classification of Ladd and Gross are a group of poor ones that will only be revealed by the use of a different basis for analysis. The purpose of this paper is to describe the long term results in sixty-three patients treated at the Boston Floating Hospital and to discuss the importance of correct postoperative management.

The most important factor in the diagnosis, treatment and prognosis of imperforate anus is the relationship between the bowel and the levator ani. Cases may be divided into those in which the bowel ends above and those in which the bowel passes through this muscle to open in the vulva or perineum. In the former group the rectum is incompletely developed, its nerve supply abnormal and easily damaged, and therefore rectal sensation, an important factor in the defecation reflex, is deficient. Also, the incidence of urinary fistulas is high. In the latter group, rectal development and innervation approaches normal, and since the bowel passes through the central portion of the levator ani, known as the puborectalis muscle, it is equipped with a sphincter. Urinary fistulas are rare in this group. For these reasons the prognosis for normal rectal function and control is better in the latter group than the former. The external anal sphincter develops independently of the rectum, but in the absence of the proctodeum it is poorly formed and seldom functions.

The cases in this series are therefore divided into two groups, termed high level when the bowel ends on or above the pelvic floor and low level when it passes through the pelvic floor. The low level cases are termed stenosed anus, covered anus and ectopic anus. The covered anus is a diagnosis based on the embryological and morphological studies of Wood Jones [12]. Excessive fusion of the inner genital folds covers a malformed anus with a layer of skin which forms a midline track running forward to a small opening on the undersurface of the scrotum or penis. The ectopic anus is one which is malformed and situated anterior to the normal position, usually in the fourchet or just outside the vulva in females, or (rarely) in the penile urethra associated with hypospadias in males. Although this nomenclature is not strictly accurate, as even in the low level cases the anal canal is imperfectly formed, it is preferable to the term imperforate anus with fistula because it denotes the embryological background of the deformities more accurately.

DIAGNOSIS

The perineum should be carefully inspected for the presence of a small cutaneous or vulval

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FIG. 1. Lateral x-ray films comparing the relationship between the gas shadow in the terminal bowel and the pubococcygeal line in a high level and a low level case.

opening which may lie anywhere between the normal anal site and the tip of the penis in the male, or the posterior border of the vulva in the female. Such an opening may be explored with a fine probe and its communication with the rectum established, indicating that the bowel passes through the pelvic floor. The presence of squamous cells in the urine proves that the bowel ends above the pelvic floor in a recto-urethral or rectovesical fistula. This simple urinary test is accurate provided the urine sample is centrifuged and the deposit examined microscopically. It is more accurate than radiography or cystography in detecting a urinary fistula. The radiological technic of Wangensteen and Rice [*10*] should be used in all cases in which doubt exists as to the level of the deformity. In an accurate lateral film, a line joining the lower border of the pubic symphysis and the sacrococcygeal junction crosses the lower limit of the levator ani muscle. In high level cases the gas bubble in the terminal bowel ends on or above this line, whereas in low level cases it passes below. (Fig. 1.) The presence of other abnormalities and the degree of sacral development should also be noted in this radiological examination. Severe sacral agenesis is frequently associated with defects in the formation of the levator ani [*9*] and bladder function [*11*], and this unfavorably affects the prognosis for both urinary and fecal control. (Fig. 2.)

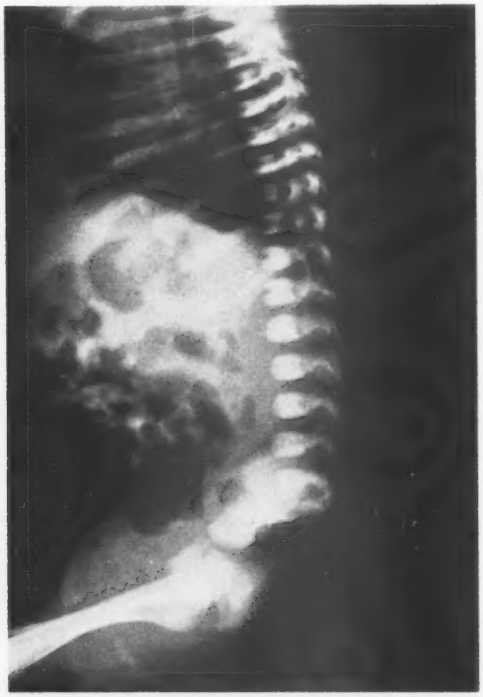

FIG. 2. Lateral x-ray film showing complete sacral agenesis.

CASES FOR STUDY

There were sixty-three cases, of which thirty-three were males and thirty females. The ages at which the patients began treatment at the Boston Floating Hospital are given in

TABLE I
AGE WHEN PATIENTS BEGAN TREATMENT AT BOSTON FLOATING HOSPITAL

Age	No. of Cases
Neonate	26
1–6 mo.	16
6 mo.–1 yr.	4
1 yr.–4 yr.	10
Over 4 yr.	7

Table I. Many of the older children received their initial treatment in other hospitals and were later referred for further advice. Thirty were regarded as high level deformities and thirty-three as low level. The single patient with congenital cloaca possessed a common perineal opening for the rectum, vagina and bladder. (Table II.)

Associated Anomalies (*Table III*). These commonly occur with an imperforate anus, most authors recording an incidence of approximately 50 per cent, although Moore and Lawrence [7] quoted 72 per cent and Dennison [2] 33 per cent. In this series there were thirty-five (55 per cent) patients with additional anomalies, twelve being in the urinary tract consisting of hydronephrosis, extrophy of the bladder, renal agenesis, double renal pelvis, and double bladder and urethra. Outside the urinary tract there were anomalies such as hydrocephalus, vertebral abnormalities, mongolism, congenital heart disease, annular pancreas and esophageal atresia. These figures are a low assessment of additional anomalies as not all the cases were completely investigated. X-ray films, which included the dorsal, lumbar and sacral spines, were available in forty-eight patients; of these, thirteen had epistasis (that is, an extra lumbar vertebra) and thirteen had sacral agenesis, seven being severe with three or less sacral vertebrae. Of this small group, three also had epistasis, leaving four (8.3 per cent) patients with a significantly severe sacral abnormality. This is a high enough proportion to command attention. With the exception of severe true sacral agenesis, associated anomalies occurred with equal frequency in both groups of patients. Therefore, all cases of imperforate anus, irrespective of the severity of the deformity, should be investigated for other anomalies with particular regard for the urinary tract. Intravenous pyelography is necessary in every case, and cystography and voiding urethrography should be seriously considered.

TABLE II
ANALYSIS OF TYPES OF DEFORMITY

Diagnosis	No. of Cases
High level:	
Imperforate anus with rectovesical fistula	9
Imperforate anus with rectourethral fistula	10
Imperforate anus with high recto-vaginal fistula	3
Imperforate anus with no fistula	8
Total	30
Low level:	
Stenosed anus	7
Covered anus (perineal fistula)	5
Ectopic anus:	
Vulval	10
Perineal	10
Congenital cloaca	1
Total	33

TABLE III
DISTRIBUTION OF ASSOCIATED ANOMALIES

Location of Deformity	High Level	Low Level	Total
Genitourinary tract	6	5	11
Sacrum:			
Epistasis	8	5	13
Agenesis	7	6	13
True severe agenesis	3	1	4
Other regions	6	6	12

TREATMENT

High Level Cases. Sixteen patients were treated by abdominoperineal anoplasty, six being neonates. Of the remaining patients, eleven were treated at other hospitals by perineal operation with poor results. Three neonates were in such a poor general condition that transverse colostomy only was performed, and they died shortly afterward. Of the patients treated by the abdominoperineal operation, two

TABLE IV
MORTALITY: CAUSES AND DISTRIBUTION AMONG TWO GROUPS OF CASES

Cause of Death	High Level	Low Level	Total
Operative	3	0	3
Other anomaly	2	0	2
Unassociated disease	2	1	3
Total	7	1	8

TABLE V
RESULTS GRADED ACCORDING TO EFFICIENCY OF RECTAL FUNCTION IN TWO GROUPS OF CASES

Functional Grade	No. of Cases		Total
High level cases:			
a	0	Good	4
b	4		
c	2	Moderate	2
d	6	Bad	13
e	7		
Low level cases			
a	8	Good	17
b	9		
c	1	Moderate	1
d	0	Bad	1
e	1		

required further perineal operations to correct rectal stricture in one and rectal prolapse in the other. Of those undergoing perineal operations, seven required additional surgery, which consisted of abdominoperineal operations in four and further perineal procedures in two, to close fistulas between the bowel and urinary tract and correct severe anal and rectal strictures. These figures support the principle that the abdominoperineal operation is the procedure of choice for the high level imperforate anus.

Low Level Cases. Thirty-one patients underwent perineal anoplasty consisting of an enlargement of the posterior anal margin or a complete posterior anal transplant. It was necessary to repeat the operation in one patient because of failure of the first attempt. Of the remaining patients, one was unfit for surgery and received medical treatment only, and the other, the patient with congenital cloaca, underwent abdominoperineal anoplasty with reconstruction of the vagina and urethra. Eleven perineal operations were performed upon infants within the first month of life, and thirteen upon infants between the ages of one and six months. When performed with care and attention to detail by an experienced surgeon, perineal anoplasty in this young age group proved to be a very satisfactory procedure.

RESULTS

Mortality (Table IV). A total of eight patients died, representing an over-all mortality of 12.7 per cent. There were three (4.8 per cent) operative deaths. Two patients died postoperatively from associated severe congenital anomalies, although in both cases transverse colostomy only was performed because of their poor general condition.

Function. The patients were traced by letters to their parents or private doctors and were examined personally whenever possible. Both bowel function and micturition were assessed, and an attempt was made to classify the results as to degrees of functional efficiency. Parents were specifically asked about the degree and frequency of soiling of the underclothing, and inquiries as to the regularity of spontaneous bowel action and the need for rectal irrigations, enemas or laxatives were made. The tone and efficiency of the anal sphincter was assessed in the children examined personally. Bedwetting, incontinence of urine by day, the inability to restrain the act of micturition and other urinary symptoms were also noted. The efficiency of rectal control was graded in the following manner: (*a*), normal spontaneous bowel movements without soiling; (*b*), normal spontaneous bowel movements with occasional soiling; (*c*), obstinate constipation relieved by regular bowel irrigations without soiling; (*d*), as in (*c*) but with soiling despite the irrigations; (*e*), complete incontinence. Groups (*a*) and (*b*) were regarded as good, (*c*) as moderate, and (*d*) and (*e*) as bad results.

High Level Cases (Table V). With seven deaths, one patient untraced and three still under the age of three years at the time of follow up, nineteen patients were available for analysis. Of these, five were between the ages of three and six years, twelve between six and twelve years, and two over twelve years. Four cases were regarded as good, two as moderate and thirteen as bad results. This represents 68 per cent bad results.

The anal sphincter was examined in twelve patients who were reviewed personally; in five, the puborectalis sling could be palpated behind the rectum, whereas in the remainder there was no sphincter muscle of any kind. In the former small group, three patients had good results, one was classed as moderate and one as bad. This latter child was one of the four who suffered from persistent diarrhea which he could not control.

Seven children had disorders of micturition due to inefficient bladder control resulting in persistent wetting. One of these was found to have unilateral hydronephrosis and hydroureter and another a traumatic urethral stricture.

Low Level Cases. There was one death, four patients were untraced and nine were below the age of three years at the time of follow up, leaving nineteen patients for analysis. Of these, six were between the ages of three and six years, twelve between six and twelve years, and one over twelve years. Seventeen were regarded as having good results, one as moderate and one bad. (Table v.) This represents 89 per cent good results. As so few children in this group had symptoms, only five were examined personally; in all, the puborectalis muscle sling was easily palpable. Five children had urinary symptoms. Three suffered almost complete incontinence and all had severe sacral agenesis, although two had epistasis as well. The remainder suffered occasional wetting for which no cause could be found.

POSTOPERATIVE MANAGEMENT

In low level cases, parents can be advised that the outlook is good provided they obey instructions to dilate the newly formed anus regularly for the first six to eight weeks postoperatively. They can expect normal bowel function and control to develop, although extra efforts in the form of laxatives or irrigations may occasionally be necessary to encourage regular evacuation. Any tendency for the anus to stenose must be prevented.

The most frequent problem in high level cases is constipation which, if untreated, proceeds to massive fecal retention with dribbling overflow incontinence. Persistent soiling causes excoriated buttocks and the characteristic odor. The misery becomes acute when the child attends school and receives one of the apt nicknames which school children rapidly invent for one another. Attempts to relieve the constipation by means of laxatives are either unsuccessful or cause copious diarrhea which the child cannot control because there is no sphincter.

The constipation is difficult to explain. Only the distal 1 or 2 cm. of bowel which is used at operation to constitute the missing rectum represents what would become the definitive rectum in normal embryological development; the remainder is colon. Therefore, only a short length of bowel is capable of producing rectal sensation, and this is frequently removed at operation and its nerve supply almost certainly destroyed. Without rectal sensation the child does not appreciate the need to evacuate his bowel and, therefore, other activities being more interesting, he does not do so at all. As a colostomy on the abdominal wall will usually evacuate spontaneously and without assistance, there must be other causes for this problem. It is possible that denervating the bowel may affect its normal propulsive activity.

Whatever the cause, the situation can be prevented by encouraging the child to evacuate regularly so that the colon does not become overdistended. If there are no spontaneous evacuations, regular rectal irrigations have to be instituted. These must be demonstrated to the parents so that they may be continued at home. In the absence of sphincter control, constipation is an advantage as the child who evacuates completely with a daily irrigation is clean at other times. Recently a substance, bis(p-acetoxyphenyl)-2-pyridyl-methane, marketed under the trade name of Dulcolax,® has been successful in a limited trial when given as a suppository instead of the daily irrigation. The principle of this management is to prevent fecal retention and the resultant overflow incontinence. Rarely a child has persistent diarrhea instead of constipation, and this is extremely resistant to treatment. Efforts should be made to solidify the feces by administering the various preparations that are available for this purpose and by reducing dietary bulk. Many of the problems that arise in the years following the initial treatment may be prevented to a great extent by a careful follow up, a fact repeatedly noted as the patients in this series were traced. Many had not been seen for long periods and were found to be in an unsatisfactory state with fecal impaction and overflow incontinence. By admitting the child to the hospital, emptying the colon with

irrigations and establishing a regular bowel evacuation program with the assistance of daily irrigations or Dulcolax suppositories, soiling was frequently abolished and the development of regular unassisted evacuations encouraged. The cause of the child's difficulties was explained to the parents who were encouraged to continue the regimen at home. In most instances they were pleased that further interest in their child was being taken, and morale was improved. Following the initial operation all patients with imperforate anus must be seen at regular intervals so that the earliest signs of impending complications may be detected and the necessary action taken. By this means the child may achieve satisfactory bowel control and avoid many of the distressing problems which otherwise occur.

COMMENTS

An attempt has been made to define the functional results obtained after surgery for imperforate anus and the patients' ages at which they have been assessed. Although the number of patients is small, it reveals a definite trend. Bradham [1] recently reviewed forty-three patients treated between 1950 and 1955, and stated that the results were satisfactory in all except three, one of whom had an abdominoperineal repair. However, there were only four abdominoperineal operations in the series, and the term satisfactory implied only that the anal opening was adequate, there being no comments on fecal control. Donovan and Brown [3] reported twenty-one cases, of which seventeen appeared to be low level, and commented that proper control never occurs; habit control and voluntary control using the gluteal muscles are all that can be achieved. This is an unnecessarily gloomy outlook when applied to the low level deformity. Nicolai [8] reported 60 per cent satisfactory results in 100 patients, 22 per cent of whom were not traced, but did not state the criteria for these results or the age at which the patients were assessed. Kiesewetter [5] had twenty-two good results in fifty-four cases of assorted deformities. He stated that these children were always continent with normal evacuation. The results were not classified according to the severity of the deformity, and the age at which the patients were assessed is not given. Gross [4], in his series of over 500 cases, found that types I and II presented no problems, whereas among seventy-three patients upon whom an abdominoperineal operation had been performed for the type III deformity, there were twenty-three with normal bowel function and seventeen were very satisfactory. This was a high proportion of good results although the age at the time of assessment was not stated.

The outstanding feature of the results in our series is the great difference between the low level and high level cases which supports the argument for this classification. It is also rational on anatomical grounds for reasons given earlier.

Although not apparent in the statistics, a strong impression has been gained during this study that the first operation is the crucial and important one. Errors in choice of operation and technic at this stage can produce long-standing misery and suffering for both the child and parents as well as insoluble problems for the surgeon. The best opportunity for achieving the best result is at the first operation. Therefore, these patients should be treated by surgeons who have the necessary training and experience in this branch of surgery, and who have at their disposal the special anesthetic, nursing and other facilities that only a pediatric unit can provide.

SUMMARY

A series of sixty-three cases of imperforate anus is described. A plea for classifying these deformities as high and low level is made, and arguments to support this are given.

Patients under the age of three years were excluded from the follow-up analysis. In the high level group 68 per cent of the results were classified as bad and in the low level, 11 per cent. It is suggested that the reason for this is the difference in the relationship between the bowel and the levator ani muscle in the two groups of cases.

Methods of preventing and overcoming postoperative complications are discussed.

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DISCUSSION

JOHN J. BYRNE (Boston, Mass.): This very scholarly presentation of a difficult problem offers a new classification of the types of imperforate anus based more on an anatomic basis than the previous one. It should be more helpful in planning surgery.

JOHN W. CHAMBERLAIN (Boston, Mass.): How often in the high level cases are anomalies of the urinary tract noted?

DR. SCOTT: I think about 12 per cent had anomalies of the urinary tract. Quite a number of children had no anatomic anomalies but rather severe functional anomalies. Some of these were due to derangement of the nerve supply.

The Management of Rectal Prolapse and Procidentia

NEIL W. SWINTON, M.D., *Boston, Massachusetts,* AND TREVELYAN E. PALMER, M.B., B.S. (Melb.), *Philadelphia, Pennsylvania*

From the Department of Surgery, The Lahey Clinic, Boston, Massachusetts.

SINCE a complete understanding of the etiology of rectal prolapse and procidentia has not yet been attained, no single effective method of treating these patients has been devised. Wright [1], in 1949, stated that he had found more than fifty different procedures recommended. Most reports consist of small groups of cases, with the authors showing a divergence of opinion as to the etiology of prolapse and procidentia and the most desirable methods of treatment. Few surgeons have acquired sufficient experience to be able to speak authoritatively on the end results of treatment, and all admit that the etiology of prolapse and procidentia in most cases seems obscure.

The term prolapse refers to an abnormal descent of the mucous membrane of the anus or rectum, with or without protrusion through the anus. Procidentia means an abnormal descent of all layers of the rectum or sigmoid with or without protrusion through the anus. The terms partial and complete can be avoided by using this anatomic classification and recording the length of descent. By common usage, the term prolapse usually refers to both conditions.

Todd [2] recently published a very interesting and provocative article dealing with possible etiologic factors in the production of complete rectal prolapse. He believes that there are probably congenital factors, such as the presence of a mesorectum and a deep rectovesical pouch, and a failure in the support of the levator diaphragm, and as an important adjunct to these defects a lack of coordination which may exist between the appreciation of the full rectum stimulus and straining. These defects, aggravated by this lack of coordination in intestinal function, may explain the development of procidentia. His article should be carefully reviewed by all interested in this subject. Figure 1 illustrates his concept of the process of normal defecation. To quote from his summary and conclusions:

"The etiology of complete rectal prolapse is unknown. Certain neurological factors give pointers as to its mode of production, as the disease is seen in patients with a cauda equina lesion where bowel care is neglected, and more rarely in cases of tabes dorsalis and disseminated sclerosis. Sensory appreciation is faulty, either as a result of poor interpretation of the normal stimulus, as demonstrated by the increased incidence of the disease in the mentally deficient or leucotomized persons, or as a result of a rectal wall abnormality with an associated hypoexcitability. The patulous anus is the result of prolonged stretching and excessive rectal distention which lead to an atonic external and internal sphincter. A straining mechanism, usually the abdominal wall musculature, must be intact, but a lack of coordination exists between the appreciation of the full-rectum stimulus and straining.

"In addition, a congenital factor, the presence of a mesorectum and a deep rectovaginal (rectovesical) pouch is apparent, and this is partly suggested by the preponderance in spinsters. The reason for failure of the levator diaphragm is not known though a congenital defect may be present here also.

"A logical surgical approach would seem to be to deal with those factors which are understood. The bowel may be shortened and made to adhere to the sacral curve, the bottom of the pouch of Douglas may be elevated, but, above all, the rectum should be pushed forward and a

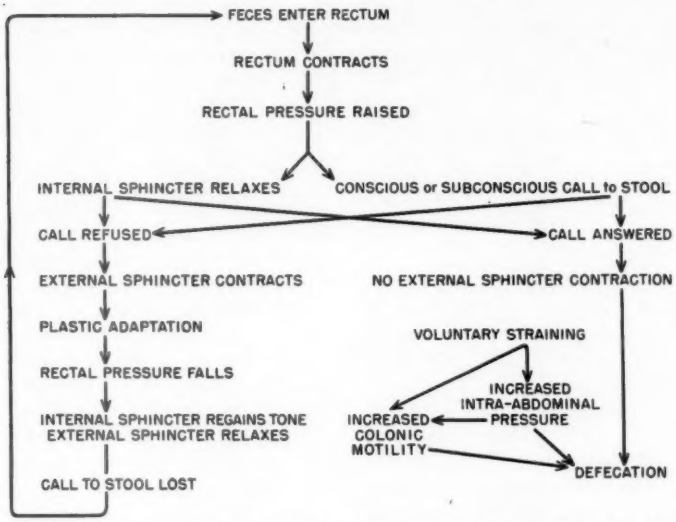

FIG. 1. Todd's concept of the normal act of defecation. (Modified from Todd, I. P. [2].)

new anorectal ring formed *posterior* to it. The anal canal may then angulate backwards in its normal manner.

"Plication operations to close the anus are illogical. The anus must be held as near shut as possible so that sphincteric tone may return. A Thiersch operation would seem the most logical 'sphincteroplasty.'"

Todd's observations seem to explain many of the factors that enter into the symptom complex of prolapse and procidentia. We have also noted other characteristics: the excessive length of the mesentery of the rectum, sigmoid and sometimes the entire colon seems to be a constant finding. Whether this is a congenital or acquired defect, we do not know; it has suggested to us the necessity for resection of the intestine in many of these patients, however.

It is particularly noteworthy that Todd emphasizes the necessity of strengthening the anorectal ring posterior to the rectum. Most operations which have been devised for the cure of procidentia have involved repair of the defect in the deep pelvic fascia and levators anterior to the rectum.

Further investigation of this concept is required. Nigro [3] has reported a small series of patients treated by a fascial sling placed behind the rectum and attached to the symphysis. Ripstein [4] and Goligher [5] have utilized a similar method. In the treatment of stress incontinence, urologists have emphasized the importance of retaining the normal acute angle between the bladder and urethra which, in some ways, is quite similar to the angle between the anal canal and rectum.

PROLAPSE

Prolapse of the anorectum usually occurs at the extremes of life. Hemorrhoids commonly accompany prolapse in elderly persons but are rare in children. Protrusions of short duration occurring in middle-aged patients should alert the surgeon to the possibility of coexisting rectal disease. Prolapse usually occurs during defecation; the mucous membrane slides along on the underlying muscularis, facilitating delivery of the stool. Persistence of this physiologic phenomenon may be influenced by the trauma of diarrhea, chronic catharsis, constipation, the loss of tissue tone as a result of advancing age, inflammatory conditions, malignant disease or indirect constitutional causes.

The treatment of prolapse of the rectum at the Lahey Clinic has been standard for many years. The presence or absence of surgically significant hemorrhoids is generally the determining factor in the type of operation employed. When mucosal prolapse is associated with hemorrhoids, a standard Stone type of hemor-

rhoidectomy is performed. The denuded areas thus obtained in the longitudinal axis of the anal canal, together with the undercutting of the mucous bridges between the defects, have led to satisfactory end results. When prolapse is not associated with hemorrhoids, a plastic amputative type of operation is performed. Follow-up studies for patients with prolapse are not included in the present series.

PROCIDENTIA

Procidentia is less common than prolapse. From 1940 through 1958 thirty-nine patients with this condition were treated surgically at the Clinic. Few children are seen by our group and none are included in this series.

Procidentia occurs most commonly in the older age groups. The average age of patients in our series was fifty-seven with a range from twenty to eighty-one years. Certain anatomic changes are commonly seen in patients of this age group, and in many cases these seem to play a part in the etiology. Such changes include the late complications of parturition, pelvic lacerations and other associated pelvic trauma. The disease frequently seems to be associated with malnutrition and muscular wasting processes. Cord transections and multiple sclerosis may result in interference with the motor control of the levator muscles and the sphincters, and these factors may be important in certain instances. The condition known as the irritable or functional colon syndrome has almost invariably been present in our patients. This is characterized by irregular bowel function, shifting abdominal pains, and usually the excessive use of laxatives, enemas and bulk foods. These patients seem to be preoccupied with this functional irregularity, frequently strain excessively at stool and almost invariably do not have a normal defecation mechanism.

Local trauma may be important in certain cases. In some, increased intra-abdominal pressure, such as that resulting from an enlarged prostate or a urethral stricture, may be important. Protracted vomiting and intra-abdominal tumors may be associated.

The two most constant operative findings in our experience deserve special consideration. First is the deep cul-de-sac and weakness or actual defect in the deep pelvic fascia and the levator muscular support of the pelvic structures. The significance of the deep cul-de-sac was first delineated by Moschcowitz [6] in 1912. He pointed out that the peritoneal sac extends into the pelvis almost to fetal position. The procidentia may be produced at laparotomy by pressure on the anterior wall of the rectum through the separated levator ani muscles. Obliteration of the deep cul-de-sac forms the basis for the original Moschcowitz procedure. In certain cases a deep cul-de-sac may be present as a congenital defect which goes unrecognized until late years. This represents failure of fusion of the peritoneal trough overlying the primitive cloaca as it divides into the two more specialized structures. In normal adults, fusion of the peritoneum overlying the anterior wall of the rectum and prostate or vagina occurs, and the bed of the cul-de-sac lies above the intact levator ani muscle. In an unknown proportion of patients this deep cul-de-sac may be produced as an acquired defect if the intestine is thrust between the weakened or defective supporting structures of the pelvis by increased intra-abdominal pressure.

Second, it is not uncommon to find almost 2 feet of redundant sigmoid colon upon opening the peritoneal cavity. The mesentery is elongated so that loops of sigmoid colon may lie in the deep cul-de-sac and everted anterior wall of the rectum. The mesentery of the small intestine may likewise be elongated so that part of the small intestine also lies in the herniated cul-de-sac outside the anus. The role of the redundant large intestine in the production of procidentia is unknown. Since our results have improved with resection of the redundant colon, we believe its presence plays a part in the etiology of procidentia. The mechanism and chain of events are not understood, however.

SYMPTOMS

Patients with rectal prolapse usually complain of a protrusion. At first this may occur only at stool and be reduced spontaneously. Later, it may occur with walking, coughing, sneezing or as the result of any increase in intra-abdominal pressure. In most instances the procidentia can be reduced spontaneously by contraction of the levator ani muscles, but in many cases it progresses so that it can only be reduced manually. Mucus and bloody discharges may be associated. The bleeding is usually bright red, not mixed with the stool and occurs in small amounts. Tenesmus, constipation and dull aching pain in the lower part of the abdomen are frequently noted.

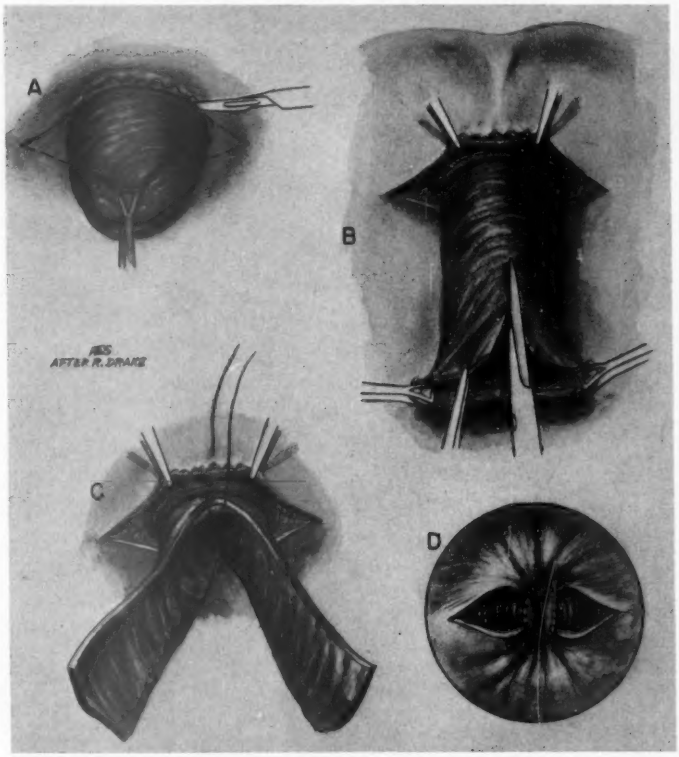

FIG. 2. Amputative type of repair of rectal prolapse. A, circular amputation of rectal mucosa at mucocutaneous junction. B, rectal mucosa has been separated from underlying submucosa, beginning resection of prolapsed rectum. C, suture of skin margin to cut end of bowel anchored through lower border of internal sphincter muscle. D, completed operation leaving V-shaped defects for drainage. (Modified from Buie, L. A. Practical Proctology. Philadelphia, 1937, W. B. Saunders Co.)

In our series of patients, the duration of symptoms varied from three months to thirty-six years, with an average of seven years.

The diagnosis can usually be made by inspection. Palpation with a gloved finger will reveal whether the protruding mass consists of mucosa only or all layers of the intestine. Also, loops of intestine may be palpated when the cul-de-sac has descended through the anus anteriorly. The presence of herniated loops may be confirmed by a resonant percussion note or bowel sounds.

In our series the length of descent varied from 1½ to 12 inches, with an average of 5 inches. Sigmoidoscopic examination is routinely made to exclude the possibility of associated rectal disease. When the history is suggestive of procidentia but no protrusion is visible, intussusception of the sigmoid should be suspected. This may be palpated as a soft, boggy mass in the intestinal lumen, separated from the entire circumference of the wall. On sigmoidoscopic examination the mucosa is seen descending and may occlude the distal end of the instrument. The mucosa is usually bright red, friable, redundant, edematous and bleeds easily.

The protruded mucosa is frequently the site of shallow ulcers. These usually heal rapidly and completely with reduction of the procidentia and correction of intestinal dysfunction. When the procidentia is of long standing, the colon is thickened, edematous and difficult to reduce. Chronic overdistention by the sphincter

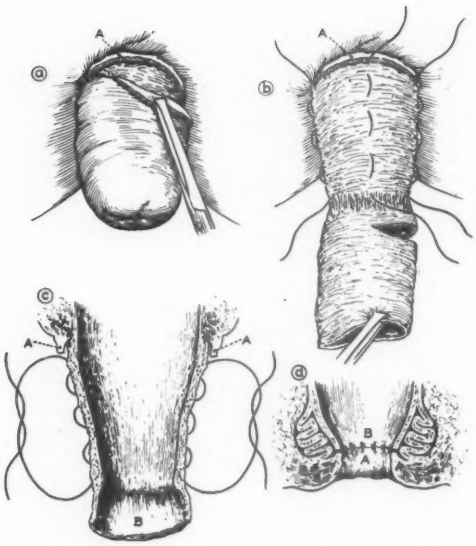

FIG. 3. Modification of Délorme procedure. a, Division of mucosa at the mucocutaneous junction. b, Mucosa separated and drawn down from underlying submucosa of bowel, showing placement of imbricating sutures between skin, serosa of bowel and cut edge of mucosa. c, Cross section of interrupted sutures placed around circumference of bowel, showing method of imbricating serosa. d, Completed procedure showing location of anastomosis between mucosa and skin of anal canal and imbrication of serosa above levators. (Modified from Lewis' Practice of Surgery, vol. 7, p. 73. Hagerstown, Md., 1936. W. F. Prior Co.)

mechanism is followed by atony and loss of continence. Strangulation is a rare complication but does occur.

TREATMENT

A wide variety of technics has been advocated for the cure of procidentia. One of the earliest was the Moschcowitz procedure reported in 1912. Moschcowitz believed that a fascial weakness was present at the point where the rectum emerged from the abdominal cavity, allowing a peritoneal sac to indent the anterior wall of the rectum and forcing it through the anal orifice. Through an abdominal approach, he obliterated this deep sac by placing purse-string sutures around it and including the pelvic fascia. This procedure alone has proved unsatisfactory [7].

Graham [8], in 1942, carried this procedure a bit further by attempting to repair the defect in the levator sling by joining the levator muscles with interrupted sutures anterior to the rectum. This procedure has not been satisfactory in many instances. It has been technically difficult to repair the defect completely because of the absence, atrophy or fixation of these structures deep in the pelvis.

Since these early reports, many types of operations have been advocated. Some authors have advocated a perineal approach, others an abdominal approach, and still others have utilized a combination of the two [3,5,9–14]. Certainly, factors in the individual cases will enter into the selection of an operation in many instances. The general condition of the patient, his age, life expectancy and degree of obesity will be factors which must be individualized.

For the very obese, the poor risk or the elderly patient with a short life expectancy, we

TABLE I
END RESULTS OF INTRA-ABDOMINAL OPERATIONS

Results	No. of Patients
With resection:	
Total (7 operations)	7
Resection	
Mikulicz	4
End-to-end anastomosis	3
Good results	6
Good result with colostomy	1
Mortality	0
Without resection:	
Total (20 operations)	17
Good result	9
Good result with secondary operation	3
Permanent colostomy	1
Slight recurrence	2
Mortality	2

TABLE II
END RESULTS OF TREATMENT OF RECTAL PROLAPSE USING DÉLORME PROCEDURE

Results	No. of Patients
Total (20 operations)	19
Strictures	3
Recurrence	6
Results	
Good	14
Fair	4
Poor	1
Mortality	0

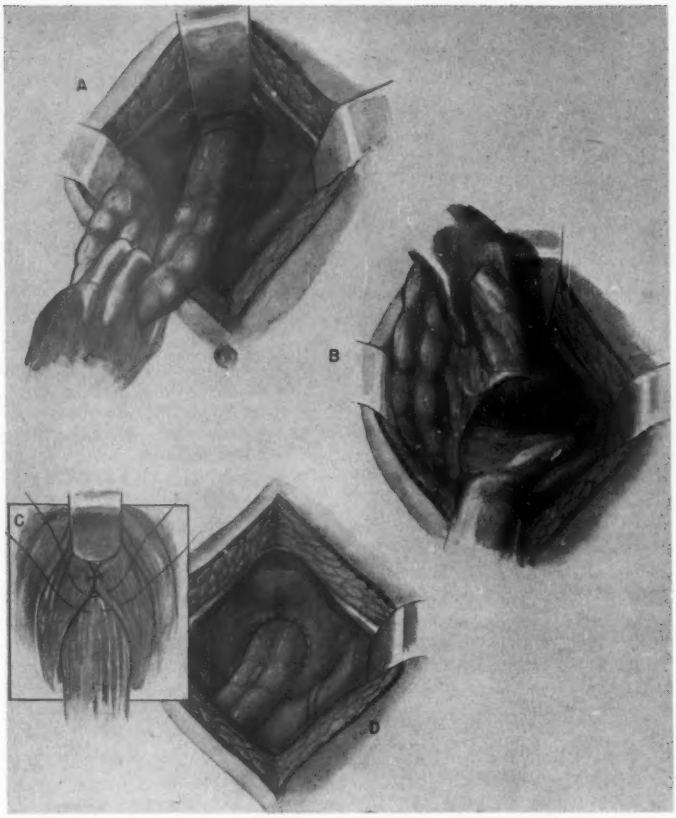

FIG. 4. Type of procedure we prefer for a good risk patient. A and B, freeing up and delivery of rectum down to levators. C, closure of defect in deep pelvic fascia. D, obliteration of deep cul-de-sac. Note: We usually perform anterior end-to-end resection of redundant bowel in addition to this pelvic delivery and repair. (Modified from SHACKELFORD, R. T. and DUGAN, H. J. Bickham-Callander Surgery of the Alimentary Tract. Philadelphia, 1955. W. B. Saunders Co.)

have generally utilized a perineal approach in performing these operations for repair of complete procidentia. Figure 2 shows an amputative type of procedure which has been satisfactory in many cases. We have favored the Délorme operation (Fig. 3) for poor risk or obese patients with extreme degrees of rectal prolapse. Although the results of the Délorme procedure in our hands have not been entirely satisfactory in all instances, it is suitable for many patients.

Operations advocated for the good risk patient in the younger age group include those devised for fixation of the rectum to the hollow of the sacrum, to the psoas fascia or to the anterior abdominal wall, and various other procedures. The procedure that we have favored at the Clinic is shown in Figure 4.

The end results in the thirty-nine patients in our series are shown in Tables I and II. We are not satisfied with these results, but with a further understanding of the etiology of this condition and more experience with the actual performance of these repairs, we believe that improved results can be anticipated. Although the Délorme operation, in all probability, does not cure the basic defects which are present, it carries almost no mortality, is not difficult technically, and in poor risk patients this type of operation plus the additional regulation of bowel function has proved satisfactory. We have no reason to believe that the end results

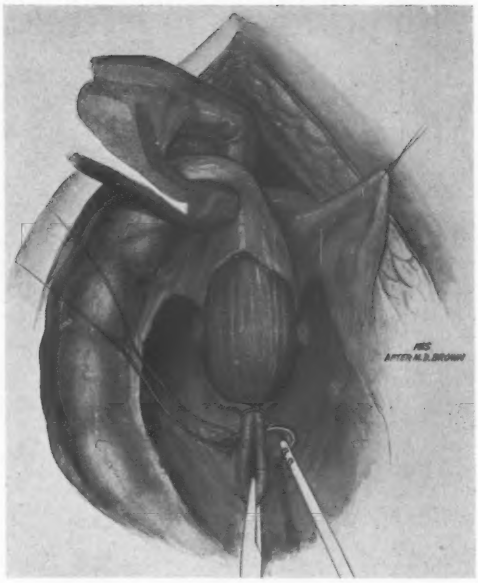

FIG. 5. Repair of puborectalis posterior to rectum, as advocated by Todd. (Adapted from Goligher, J. C. [5].)

will be any better than those following simple amputation.

For good risk patients we prefer an intra-abdominal procedure. Repair of the deep pelvic fascia, when possible, and obliteration of the deep cul-de-sac are essential. Todd's concept of the importance of posterior support to the rectum intrigues us, and certainly improved methods providing this type of support are indicated. (Fig. 5.) Resection, either by end-to-end anastomosis or by a Mikulicz type of implantation in the anterior abdominal wall, is indicated in those patients with extreme degrees of intestinal redundancy. We have always considered the establishment of normal bowel habits in these patients, even after extensive intra-abdominal operations, to be of the utmost importance in preventing recurrences.

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DISCUSSION

JOHN J. BYRNE (Boston, Mass.): I am particularly interested in the end results of the Délorme procedure. What are some of the methods you use? How much bowel do you pull down?

DR. SWINTON: There is only one thing you can do wrong, and that is pull down so much bowel that too much tension results. I think we have taken as much as 28 inches, with the average being about 10 inches. Once you have pulled out the bowel as far as it will come (I prefer spinal anesthesia for the greatest possible relaxation), peel off the mucosa thereon. Some bleeding will occur at this point and a little attention to hemostasis is advisable. Clamps should be put on the margin of mucosa when amputation is performed.

I then use four key sutures and one in between. Thus, I use about twenty-four catgut sutures.

ROBERT TURELL (New York, N. Y.): I have tried numerous operations for this unsatisfactory lesion, but I prefer only two. From my own experience, the Thiersch operation is the simplest operation I have performed. It is not definitive but nevertheless the prime results have been so good that I have adopted this as the first operation. When this fails I like to perform the amputation type which has been championed in this city by

Dr. Parker Hayden. This is nothing but a perineal portion of the abdominoperineal operation.

These two operations have served me well. Only one of the twenty-four Thiersch operations that my associates and I have performed had to be repaired, using the amputation type of procedure.

QUESTION: What is the Thiersch operation?

DR. TURELL: It consist of simply placing a wire in the skin deep subcutaneously but not involving the border of the lower muscle. It can be carried out in less than ten minutes. We have had assistant residents perform it who have never seen the operation before. You make a wire ring and twist it. Incidentally, we have had about four fractures from the wire.

DR. BYRNE: This does not correct this long defect in the colon?

DR. TURELL: It corrects nothing. It is not a definitive operation. The only definitive type of operation I know today is the amputation.

QUESTION: I would like to ask a question regarding the Thiersch operation. Are you not afraid of putting a permanent body into the field which would result in infection?

DR. TURELL: The wires are in the subcutaneous tissue which is a sterile area.

QUESTION: What size wire?

DR. TURELL: Size 19 silver wire is preferred. Other sutures, such as stainless steel wire, will not work. Also, I think one wire is enough.

CHARLES B. RIPSTEIN (New York, N. Y.): I suppose it is only fair to add more confusion to this already confused subject. I think Dr. Swinton has brought out the factors, and nobody knows which is the most important one. However, over the last fifteen or twenty years I have been impressed by the fact that these patients who have had a straightening out of the rectal tube are more liable to prolapse than are normal persons in whom the rectum is back in the wall of the sacrum. I have tried to correct that factor accordingly.

I agree with Dr. Swinton; it is extremely difficult to repair the pelvic defect. For this reason I cut a pantaloon strip of fascia which is sutured anteriorly with its two tails crossed in behind to support the rectum.

I have operated upon thirty-two patients over an eighteen-year period and the results have been reasonably satisfactory. There have been two operative deaths in this group. Of those patients who have survived over five years (many in the older age group die of other causes without having prolapse), there have been only three recurrences. I have not been completely happy but still am not dissatisfied with these results.

I also believe these patients, especially the young ones, have a peculiar mental make-up.

CHRISTOS ECONOMOPOULOS (Boston, Mass.): I am very glad that Dr. Turell brought up the subject of two operations. With Dr. Swenson we applied this method recently and the results were excellent. Dr. Turell is the first in this country to introduce this very old method. It was described by Dr. Thiersch in 1871 in Germany, and for the last eight decades it has proved to be a very good method for European surgeons. I think it is a very simple procedure. We use nylon instead of wire because the wire stitch can break and cause fistulas. With the nylon there is not trouble and it can be removed after six weeks.

The Role of Surgery in the Management of Ulcerative Colitis

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ULCERATIVE colitis is a disease of unknown etiology, and no specific therapy is known. Because of this, many types of treatment have been advocated, and most patients respond to medical or psychiatric therapy to a sufficient degree to enable them to pursue a fairly normal life.

In about 25 to 30 per cent of patients conservative therapy fails, and surgery is necessary either as a life-saving measure or to rehabilitate the patient from a life of chronic invalidism. The indication for surgical intervention may be listed as follows:

I. Acute fulminating disease or acute exacerbation
   - A. Hemorrhage
   - B. Perforation
   - C. Severe toxemia

II. Subacute and chronic disease
   - A. Intractability
     1. Diarrhea, abdominal cramps and rectal discomfort
     2. Anemia and hypoproteinemia
     3. Arthritis
     4. Damage to the liver
   - B. Anal fistulas and incontinence
   - C. Strictures
   - D. Carcinoma

The acute fulminating attack of ulcerative colitis presents a difficult problem in judgment. Mortality is high without surgical intervention, and death may occur from hemorrhage, perforation with peritonitis, or from septicemia. On the other hand, many patients respond to conservative therapy and recover with a colon which appears to be free from disease. The chief difficulty is to distinguish between these two groups before the patient is moribund and surgery becomes a futile gesture. Obvious hemorrhage or perforation demands immediate intervention but continued careful observation is necessary to detect impending perforation. An x-ray film of the abdomen has been a useful aid. Free peritoneal air, obliteration of the properitoneal fat line or the presence of a distended atonic colon are reliable signs of actual or impending perforation. It is most important for the surgeon to see these patients from the onset of symptoms and to participate in their medical therapy; otherwise he is placed at a disadvantage in recognizing changes in the local condition and in judging whether or not intervention is indicated. This attitude has resulted in a marked improvement in our results. Of forty-three patients who underwent colectomy for acute ulcerative colitis, there were two deaths giving a mortality of 4.6 per cent [1]. There were no deaths on the medical service during this period so that the mortality rate of the hospital for acute ulcerative colitis has fallen to approximately 2 per cent.

The indications for surgery in chronic ulcerative colitis are more difficult to define. There is no argument about the need for surgery when the complications of carcinoma, stricture or fistula exist. The question of intractability presents a real problem and can only be decided on an individual basis. In general, when permanent organic change has occurred in the bowel and symptoms are severe enough to cause chronic invalidism, surgery is indicated.

CHIOCE OF OPERATION

It has become apparent that the only type of effective surgery in ulcerative colitis is

removal of the diseased colon [2]. This should be performed in one stage because lesser operations carry a higher mortality. The reason for this seeming paradox is that all causes of mortality reside in the diseased bowel and are eliminated with its removal. If the colon is left *in situ*, blood and protein loss continues, toxic absorption and septicemia may occur and perforation with peritonitis may ensue. These factors are responsible for the high mortality from ileostomy alone and their removal accounts for the low mortality associated with colectomy which is now 4.3 per cent (nine deaths in 210 operations) [3].

It is rarely necessary to remove the rectum at the time of colectomy. The presence of rectal carcinoma, perforation or bleeding may make this desirable but abdominoperineal resection adds a great deal of shock to the operation and should be avoided. Ileorectal anastomosis may be considered in about 25 per cent of patients if the rectal mucosa becomes normal on biopsy. If active disease continues despite ileostomy and intensive medical therapy, resection of the rectum is indicated. This should be performed six to twelve months after colectomy, and it has proved to be a safe procedure with few complications. In 110 operations for removal of the rectum following colectomy there were no deaths and minimal morbidity. We have not encountered a single instance of impotence or sterility in patients in the younger age group (under forty years).

It is apparent that in most persons a permanent ileostomy is the price that must be paid for restoration to health from ulcerative colitis, and this has been the case in 186 of 210 patients who underwent colectomy. Ileostomy is usually well tolerated and places little or no limitation on the patient's ability to work and enjoy life. However, it is obvious that colectomy would be much more acceptable if intestinal continuity could be restored. Anal ileostomy has been a dismal failure and we are convinced that abdominal ileostomy is preferable because the patient can care for his stoma. Low ileorectal anastomosis has been advocated, and in selected cases good results are being obtained [4]. However, the follow up is short and only 25 per cent of our patients could even be considered for this procedure.

SUMMARY

1. Surgery is indicated in ulcerative colitis when life is threatened by the disease or its complications and chronic invalidism occurs.

2. The surgical procedure of choice is primary resection of the colon with preservation of the rectum.

3. Permanent ileostomy is necessary in most instances but ileorectal anastomosis may be feasible in selected cases.

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DISCUSSION

Bentley P. Colcock (Boston Mass.): I agree almost completely with Dr. Ripstein. I have performed ileoproctostomies on about four patients in the past two or three years and they are doing well; however, the fact that we found only four cases shows how seldom it is possible to perform the procedure.

Our usual procedure is ileostomy with resection of the colon down to the sigmoid. In a few cases I have removed the rectum at the same time.

Certainly with massive hemorrhage or multiple imminent perforations of the colon, ileostomy alone would not be satisfactory. The only time we might be willing to perform ileostomy alone is in a severely toxic patient who is not hemorrhaging.

Question: I would like to ask Dr. Ripstein if he has ever seen a patient with ulcerative colitis whom he thought was truly normal emotionally?

Dr. Ripstein: I do not know whether these patients are abnormal because of their disease or whether the disease is due to their abnormality. A physician who suffered from ulcerative colitis told me that he had to govern his entire life by his colon. When this continues for a period of time I defy anybody to be normal emotionally.

One of our psychiatrists who studied all the cases of ulcerative colitis we had over a three-year period found no common emotional or psychiatric factor. Certainly after people are restored to health following colectomy there is a dramatic change.

Hemorrhoids: Advances and Retreats

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HEMORRHOIDS have been mentioned in biblical and other historic writings; the condition is as old as mankind itself. The surgical history of hemorrhoids has been lucidly discussed [1]. In brief, all modern technics of hemorrhoidectomy are based on the principles first enunciated by Hippocrates, namely, ligation and excision. Although hemorrhoidectomy still appears to offer the most dramatic and effective relief for many patients [2], it has been subject to criticism of varying degrees of fairness from time to time [3,4].

ANATOMY AND PATHOGENESIS

The plexus of the tributaries of the superior hemorrhoidal veins (internal plexus) begins in the anorectum and lies predominantly in the submucosa under loose and redundant columnar mucosa. This anatomic arrangement is not only devoid of substantial support but also predisposes to the formation of varices. Two of the varices with the accompanying redundant mucous membrane are situated in the right lateral wall, one anteriorly and the other posteriorly, while the third one is located on the left lateral wall. These are the three main or primary internal hemorrhoids; smaller ones may be located between the primary ones, especially in the midline posteriorly. This internal hemorrhoidal plexus anastomoses to a variable extent with the external venous plexus which lies in the subcutaneous space of the perianus. The plexus of the rectal veins, in common with the portal veins and its branches which receive part of the venous blood from the hemorrhoidal area, possesses no valves. Absence of valves within the hemorrhoidal veins and lack of substantial support of the venous plexus in the submucosa of the rectum constitute substantial anatomic handicaps that may be responsible for the reverse flow of the venous blood (Fig. 5); these handicaps may be aggravated by the factor of gravity favoring stasis in the vascular tree and resultant passive congestion. Added to this is the element of physiologic passive congestion which usually occurs after meals. Passive congestion may also be produced by lesions causing portal vein obstruction and by pelvic inflammatory and neoplastic disease, uterine displacements, pregnancy, urethral obstruction, neoplastic or inflammatory proctologic disease, and the injudicious use of cathartics. These factors also impair the efficiency of the anorectal musculature and, depending on the progress or stage of the pathologic process, will result either in anal spasm or relaxation with consequent prolapse of the rectal mucosa.

Studies of the causation of hemorrhoidal disease are still controversial or inconclusive. Parks believes that constipation is the single essential issue [5]; the fecal mass is said to impair or block the venous outflow while the arterial inflow continues practically undisturbed. Constipation, *per se*, has, however, not been a very frequent factor in more than 2,000 personal cases of hemorrhoidal disease.

I now consider the role of infection of the perianal structures as of questionable or no etiologic importance. Hemorrhoidal tissue removed at operation and obtained from rectums extirpated for cancer, as well as that removed at necropsy from subjects with non-intestinal disease, invariably shows the same histologic picture, namely, dilated veins with no or variable degrees of inflammatory reaction but without evidence of infection. A histologic report such as the following is quite common: The hemorrhoidal vessels are large, numerous and lie very superficially beneath the epithelium; none appear thrombosed; inflammatory reaction is absent [4]. I also cannot accept the concept that hemorrhoids are a collagen disorder, as Klemperer has shown that collagen

diseases are generalized and not local alterations of extracellular components of connective tissue. Hemorrhoids are hardly a systemic disorder! It has been suggested that in some patients hemorrhoids are produced by arteriovenous fistulation similar to varicose veins of the lower extremities.

A familial tendency toward the formation of hemorrhoidal varices is quite conspicuous in many patients. I have treated hemorrhoidal disease in three generations of the same family very frequently, and even four generations on occasion. Recently I have noted a number of patients in whom occupational strain or stress played an important role in precipitating the prolapse of existing internal hemorrhoids [6].

DIAGNOSIS

Symptomatology. The three cardinal symptoms are (1) bleeding, (2) protrusion and (3) pain; they do not necessarily occur in this order. Bleeding may be occult or gross and varies from a few drops to large amounts. Bleeding may be caused by superficial mucosal abrasion or ulceration, or by rupture of any of the veins (particularly the larger ones) which follows vascular distention of the pile. Distention may be the result of obstruction to the outflow of venous blood while the inflow of arterial blood continues unhampered. This occurs especially following the postdefecatory prolapse of an internal pile that is not reduced promptly, either spontaneously or digitally. With stagnation of blood a rupture of venules may occur, resulting in extravascular and intravascular thrombosis associated with varying degrees of edema which may obscure the anatomic landmarks to a great extent. In these cases pain may be severe and is accentuated by the contracting action of the anal musculature.

Protrusion of internal piles is usually associated with a relaxed anal sphincteric musculature and progresses slowly. This slow or chronic process at times becomes acute when the protruding hemorrhoidal mass remains unreduced or becomes suddenly enlarged as a result of submucous rupture of a vein or thrombosis. Under these circumstances the prolapsing mass literally becomes strangulated, resembling impending gangrene, by the contracture of the sphincteric muscles. Unless promptly reduced, the pain may be excruciating.

Ordinarily internal hemorrhoids which prolapse after defecation reduce themselves or stay reduced after digital reposition. However, with the gradual development of a patulous anus, owing at least to partial decompensation or atonicity of the sphincteric musculature, the internal hemorrhoids remain permanently extruded and are subject to undue direct trauma, ulceration and thrombosis. This clinical picture is distinct from that of strangulation in which the anal sphincteric musculature is in spasm. In the former, reduction may be possible but prolapse follows reposition immediately.

The clinical picture of prolapse, engorgement, edema, thrombosis and even variable strangulation of internal piles with secondary involvement of any component of the sphincteric musculature is not to be confused with so-called external thrombosed hemorrhoids. The latter, in the strict sense of the word, is not a hemorrhoid at all but a hematoma in the perianal stuctures due to rupture of a venule with extravasation of blood and the formation of a localized blood clot. The subdivision of the perianal subcutaneous tissue into a honeycomb by tough fibroelastic septums may explain the localization and painful nature of a perianal hematoma.

Hemorrhoids should never be accepted as the cause of gastrointestinal bleeding until complete proctologic and general physical examinations (to exclude causative systemic disease) have been made. All patients with overt or occult rectal bleeding, regardless of age, should have sigmoidoscopic and radiographic examinations to exclude the presence of an adenoma or cancer. (Fig. 1.) Likewise, a complete blood count is mandatory to recognize blood dyscrasias which are frequently causes of rectal bleeding, and to judge how much anemia is present as a result of blood loss. Patients with unexplained iron deficiency anemia should be accorded a proctoscopic survey to determine whether unsuspected internal hemorrhoids (and other lesions such as an adenoma or cancer) are the source of the slow or chronic blood loss which, when accompanied by a blood volume deficit, may create a clinical picture resembling organic heart disease.

Examination. The diagnosis of hemorrhoids can usually be made on inspection alone. Unless a hemorrhoid is indurated by inflammation or is the seat of a thrombus, it cannot be palpated; this is a common misconception. Prolapse can easily be demonstrated by asking the patient to strain mildly especially in the squatting posi-

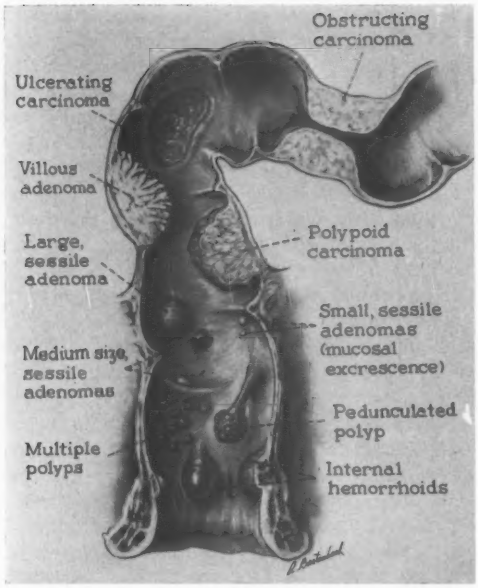


FIG. 1. The three common lesions that produce bleeding via the anus. (FROM: TURELL, R. Diseases of the Colon and Anorectum. Philadelphia, 1959. W. B. Saunders Co.)

tion. (Fig. 2.) Prolapsing pink mucosa invariably follows mild straining after the insertion of an anoscope and insinuates itself into the opening of the instrument; it may follow to the exterior after removal of the anoscope. The level at which the mucosa begins to insinuate itself into the distal end of the anoscope is believed to correspond to the level of the anorectal ring where the uppermost part of the pedicle of an internal hemorrhoid resides. Anoscopy is followed by sigmoidoscopy for the visualization of at least 25 cm. of the terminal bowel. In my practice, x-ray films of all patients with bleeding, regardless of age, are taken with double contrast media, in addition to endoscopy to establish the presence or absence of concomitant lesions, primarily adenomas and cancer.

Sigmoidoscopy does not require a proctologist; many progressive internists, general surgeons, and general practitioners have trained themselves to perform sigmoidoscopy, which can be mastered only with practice [7]. Endoscopy, for a distance of at least 15 cm. from the anal verge, should be made a routine part of every physical examination. The endoscope should be inserted into the rectum gently and advanced equally gently under visual guidance only. (Fig. 3.) Endoscopy should be discontinued promptly whenever the lumen of the bowel ahead of the endoscope is obscured either by angulation (Fig. 4), feces, blood or an impassable lesion, or if the patient is unduly uncooperative or restless.

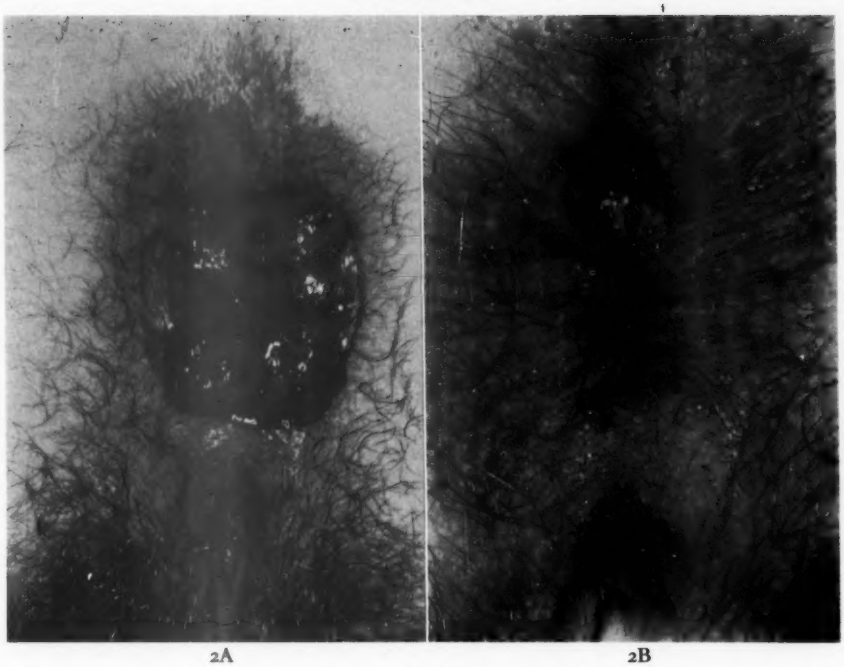
TREATMENT

The management of hemorrhoids offers three alternatives: they may be neglected, injected or resected. In my experience with over 2,000 patients, the hemorrhoids in over 20 per cent of patients were so nearly symptomless as to require no therapy.

In spite of a voluminous literature, the merits and demerits of injectional sclerosing and surgical therapies are still poorly understood by most of the profession. This is largely the result of overemphasis on injectional therapy by those incapable of performing surgical procedures, and undue stress on the operative approach by surgeons who are unacquainted with the conservative methods of treatment. Anyone who undertakes to treat hemorrhoids should be capable of performing both forms of therapy [4,8].

Sclerotherapy. In 30 per cent of patients injectional sclerosing therapy is effective. Sclerotherapy is utilized for the treatment of small- to medium-sized internal bleeding hemorrhoids with or without spontaneously reducible prolapse. Prior to the institution of sclerotherapy, it is imperative to establish the absence of active or latent inflammatory disease of the anorectocolonic tube. The sclerosing agent utilized in most patients is a 5 per cent solution of quinine and urea hydrochloride; a 5 per cent solution of phenol in pure almond oil is also popular. The first injections are made submucously about the pedicle of each hemorrhoid. Subsequent injections are made into the hemorrhoidal masses interstitially at a lower level. (Fig. 5.)

By producing a sterile inflammatory reaction at the sites of the injections, a chemical thrombosis of the vessels is produced, followed by sclerosis and finally by fibrosis. The main clinical purpose is to stop the bleeding and correct associated mild prolapse. About 65 per cent of treated patients remain free from symptoms for as long as three years or more. Reinjection is required in about 30 per cent of patients because of recurrence of bleeding [8].



2A 2B

FIG. 2. A, protrusion of internal hemorrhoids following straining with patient in squatting position. B, absence of rectal protrusion in same patient when not straining. (FROM: TURELL, R. Diseases of the Colon and Anorectum. Philadelphia, 1959. W. B. Saunders Co.)

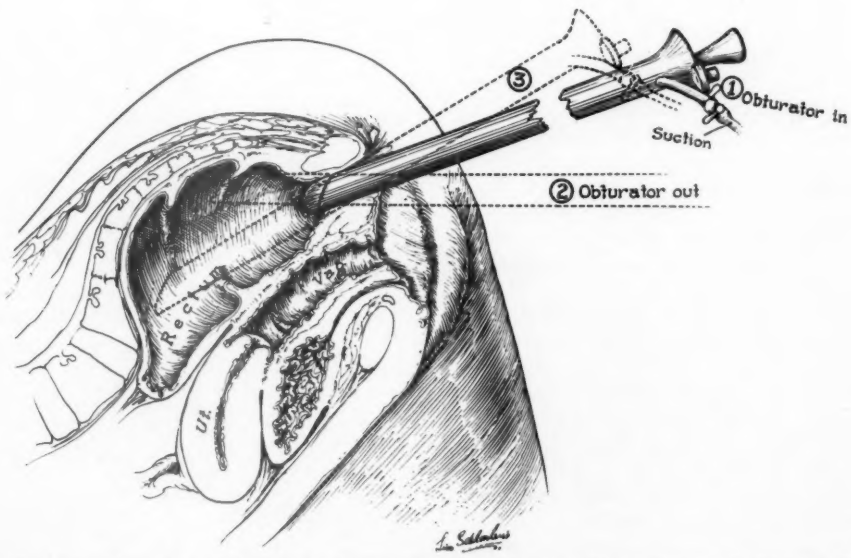


FIG. 3. Positions of the endoscope in the process of sigmoidoscopy. (FROM: TURELL, R. Diseases of the Colon and Anorectum. Philadelphia, 1959. W. B. Saunders Co.)

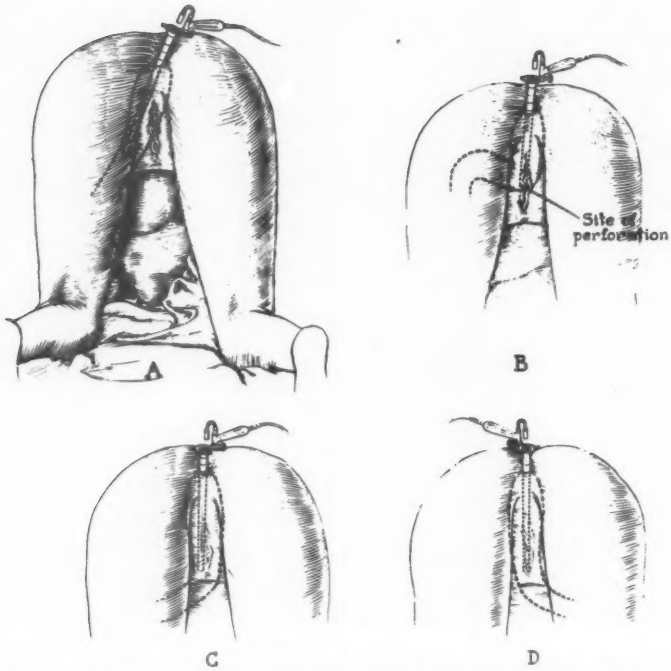


FIG. 4. Note mild angulations of the bowel in (C) and (D), which can easily be overcome by gentle manipulation, and extreme angulation in (B) plus the usual site of perforation. (FROM: TURELL, R. Diseases of the Colon and Anorectum. Philadelphia, 1959. W. B. Saunders Co.)

Sclerotherapy apparently does not always produce a permanent cure. A cure depends primarily on (1) the fate of the fibrosis which is a biologic unpredictability and (2) the elimination of the causative or precipitating factors which have existed prior to the institution of sclerotherapy, if these are ascertainable.

Properly performed injectional therapy should not produce serious complications, such as severe ulceration, hemorrhage, suppuration, irreducible prolapse, etc. [8].

Surgical Therapy. Forty per cent of patients require hemorrhoidectomy. They have either large internal or mixed hemorrhoids with pain, protrusion or bleeding. The choice of anesthesia is a regional (caudal) or saddle (spinal) block. Inhalation anesthesia is utilized only for the apprehensive patient. The preoperative preparation consists only of a cleansing saline enema which is optional; shaving of the anal area is also optional. Of the operative technics (the large number of technics of hemorrhoidectomy described in the literature indicates dissatisfac-

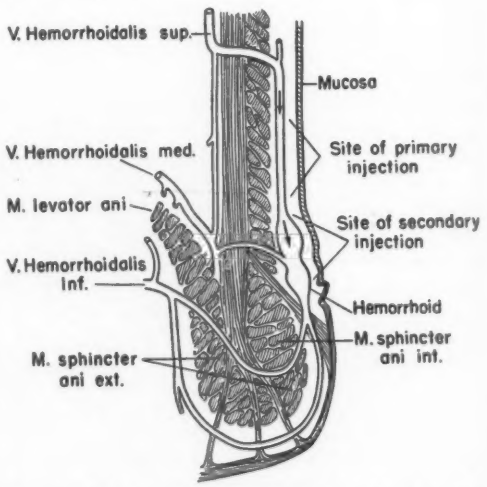


FIG. 5. Note the primary and secondary sites of injection. The arrows indicate the reverse flow of blood in the presence of hemorrhoids. (FROM: HILLER, R. I. Internal hemorrhoids; their pathogenesis and the rationale of injection therapy. *Am. J. Surg.*, 16: 64–67, 1932.)

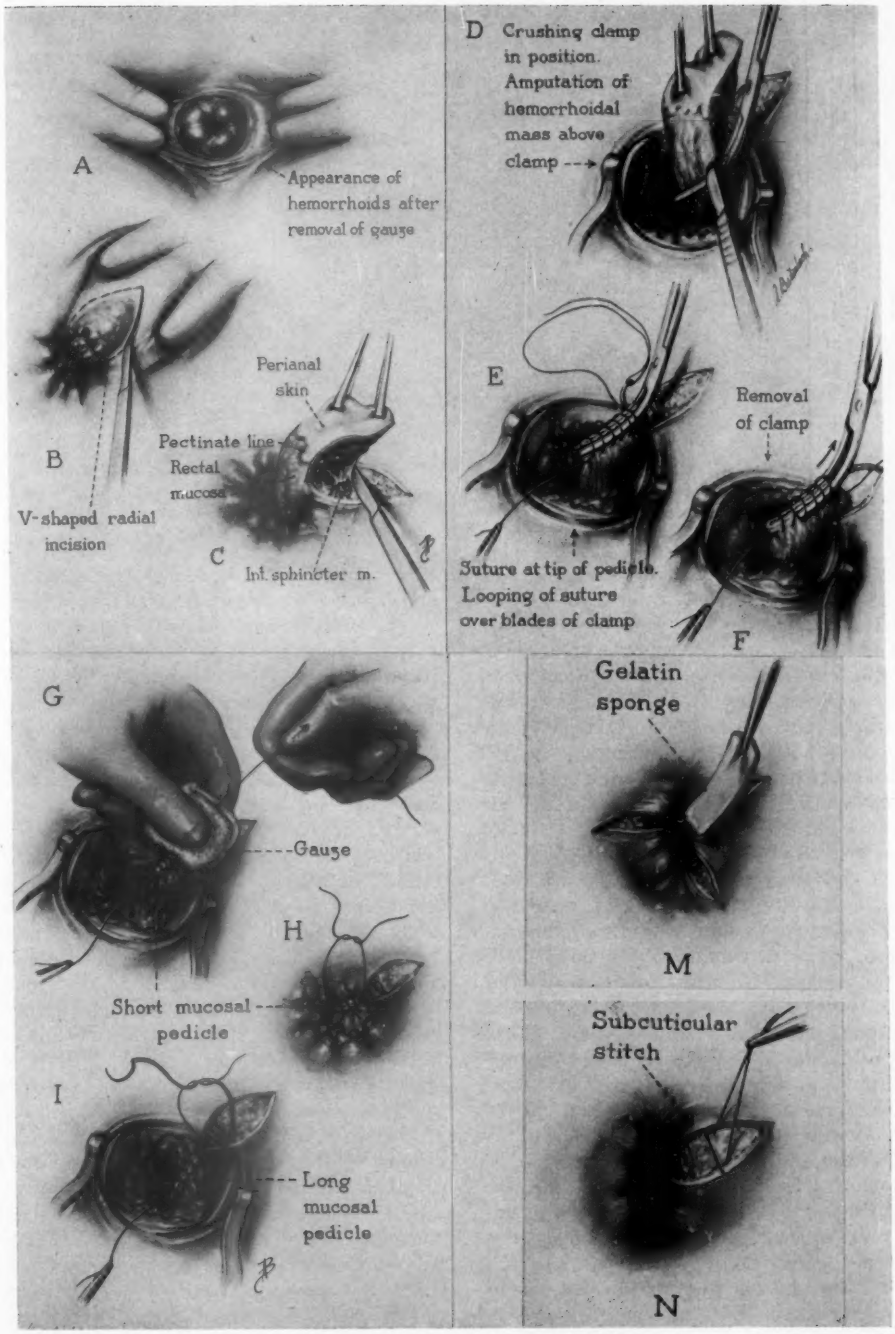


FIG. 6. Technic of open type hemorrhoidectomy described in the text. (FROM: TURELL, R. Diseases of the Colon and Anorectum. Philadelphia, 1959. W. B. Saunders Co.)

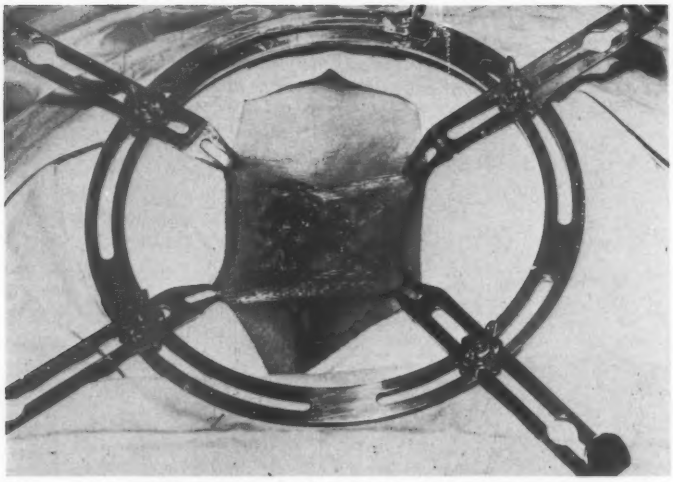


FIG. 7. Note excellent exposure of the field of operation produced by the author's newly designed anal ring retractor. (FROM: TURELL, R. and KAMENS, E. A. Aids in proctologic surgery. *Surg., Gynec. & Obst.*, 103: 643, 1956.)

tion with the operation by many surgeons), the open type of hemorrhoidectomy is usually utilized [*9,10*]. (Fig. 6.) The operative procedure to be described may readily be taught to surgical interns and residents. Modifications to suit special cases are freely employed, but always in keeping within the framework of the underlying principles of the technic.

Technic: After induction of anesthesia, the patient is placed in the prone position and the table adjusted so that a modified jackknife position is secured. The perianal skin is cleansed and treated with an antiseptic solution or alcohol. Although all patients, as a rule, have a complete proctosigmoidoscopic examination prior to admission to the hospital, the anorectal field is re-examined, first digitally and then instrumentally, using a suitable anoscope and an anal retractor. Several strips of gauze are then introduced through the anoscope into the rectum and are held in place with a long anatomic forceps until the instrument is removed. Gentle and somewhat circular withdrawal of the gauze is believed to produce an imitation of a bowel movement and thereby bring the internal hemorrhoids into view in the manner in which they protrude during the natural act of defecation. (Fig. 6, A.) This maneuver may be omitted by the use of the anal ring retractor. (Fig. 7.) This ring affords excellent exposure of the operative field with ease in most patients and makes possible the execution of a difficult hemorrhoidectomy with the aid of only one assistant, an intern or nurse.

The perianal skin above the summit of the external hemorrhoid is held taut and gently retracted away from the anus with the aid of the index and middle fingers. This maneuver produces a slight cutaneous depression at the borders of the hemorrhoidal mass which is the site of a V-shaped radial incision that is continued on each side of the hemorrhoid slightly beyond the dentate or pectinate line which is the end of sensory innervation. (Fig. 6, B.) This maneuver may be facilitated by the use of the anal ring retractor [*10*]. The tip of the V-shaped incision is grasped with an Allis forceps and dissection is begun. More Allis forceps are placed on the hemorrhoidal mass to facilitate exposure. The hemorrhoidal mass with the accompanying anal crypts or papillae is freed from the subcutaneous and submucous structures by a combination of sharp dissection and gauze-covered digital separation. (Fig. 6, C.) In this dissection the muscle fibers of the lower border of the internal sphincter muscle are plainly visualized.

The separation of the hemorrhoidal mass is continued until the mucosal pedicle appears free. A Smith or other type [*10*] of crushing clamp is then applied radially to the mucosal pedicle in the long axis of the anal canal so as to remove all the hemorrhoid-bearing and at times normal but redundant and prolapsing mucous

membrane. (Fig. 6, D.) With a sharp scalpel the hemorrhoidal mass is removed at the top of the clamp. (Fig. 6, D.) One or two turns of No. 1–0 chromic catgut suture is placed beneath the tip of the clamp and tied (Fig. 6, E); this maneuver aims to control the main blood supply to the hemorrhoid. The suture previously tied at the tip of the clamp is now continued and looped around the shank of the clamp. (Fig. 6, E.) The clamp is opened, loosened and removed (Fig. 6, F), and the distal and proximal ends of the suture are joined and tied. (Fig. 6, G and H.)

In compression of the pedicle the mucosa is pushed lightly against the looped suture, which in this process is straightened, thus holding the approximated edges of the mucosa. If the mucosal pedicle is so long that the resulting stump will be unduly large, the distal end of the suture is not joined with the proximal one but is tied separately at the distal end of the pedicle. (Fig. 6, I.) The stump is allowed to retract into the rectum; it is practically never anchored to the region of the pectinate line. The remaining primary hemorrhoids are dealt with in a similar manner but each hemorrhoid is amputated at a somewhat different level in order to avoid a circular mucosal constriction. All tags and other irregularities are trimmed away in a manner to bring the outer edges to a point.

If there is enough intervening mucous membrane present to separate the wounds, the secondary hemorrhoids, if present, are removed in a manner similar to that of the primary ones. Otherwise the mucosa is undercut and undermined, and the varicosities are removed submucously.

At the conclusion of the operative procedure the rectum and the operative sites are inspected. The wounds are covered with moistened gelatin sponge. (Fig. 6, M.) Substitutions consisting of newer substances are now in the process of personal evaluation. These nonadherent substances disintegrate spontaneously within twenty-four to forty-eight hours; packs, drains or plugs are no longer used. Occasionally two of the three primary wounds are approximated by means of interrupted subcuticular stitches of No. 2–0 plain catgut. (Fig. 6, N.)

Huge hemorrhoids occupying half or more of the anal circumference may require more radical plastic procedures.

Open versus Closed Wounds. During World War II an opportunity was afforded to compare and contrast the results of the open type of hemorrhoidectomy herein described with the semi-closed and closed types of hemorroidectomy. The semi-closed method of hemorrhoidectomy was essentially the same as the open type except that the subcutaneous structures of the hemorrhoidal bed were approximated without suturing the skin. In the closed type of hemorrhoidectomy, the wounds, including the skin, were closed following removal of the hemorrhoidal mass.

Early in the investigation it became apparent that with the open operation even large hemorrhoids could be completely removed, and the preoperative course was smooth and uneventful. Seldom did a patient require more than two doses of morphine postoperatively, and about 40 per cent of the patients required none at all. However, following this open operation the soldier was seldom discharged to duty in less than three weeks.

With the semi-closed type of hemorrhoidectomy considerably more morphine was required for postoperative sedation. Furthermore, the postoperative course in about 20 per cent of the patients was complicated by the onset of varying degrees of induration and tenderness in the wounds which in many instances, however, disappeared spontaneously. Sulfonamide and/or antibiotic drugs administered preoperatively and postoperatively had little effect on the incidence of development of this complication. However, in the uncomplicated cases a faster rate of wound healing was discernible than in the controls; the wounds healed effectively in about two weeks.

Following the closed type of hemorrhoidectomy, the postoperative course was quite stormy in some patients. About four times more morphine was required for the control of postoperative pain after this than after the open operation. In over 50 per cent of the patients induration developed with considerable tenderness, which in a few instances eventuated in localized suppuration requiring drainage. Also, in a number of patients relative anal stenosis developed after the closed type of hemorrhoidectomy. The definite advantage of the uncomplicated closed type of operation was the saving of duty or work hours, as the patient could be discharged in less than ten days.

In summary, the open type of operation was

singularly free from complications such as induration, localized cellulitis or infection of the wounds, and did not produce undue postoperative pain or discomfort. The patient could not, however, be discharged to duty in less than three weeks [9].

The semi-closed method, on the other hand, returned the soldier to duty in about two weeks. The rate of occurrence of induration with tenderness in the wounds is relatively low and may resolve spontaneously or with the aid of sulfonamides and/or antibiotics. In spite of these disadvantages I favor this type of hemorrhoidectomy in civilian practice whenever the saving of time is of paramount importance. It appears to be superior to immediate skin grafting of the wounds.

The closed type of hemorrhoidectomy is apparently not a procedure to be recommended in spite of its time-saving feature, as this is offset by the high incidence of complications such as induration and occasional suppuration of the wounds and infrequent occurrences of relative anal stenosis requiring periodic digital dilatation [9].

POSTOPERATIVE CARE

Following the performance of the open technics of hemorrhoidectomy, the pain is minimal and may easily be controlled by narcotics or derivatives of the coal tar drugs; rarely are more than two injections of either morphine or levorphan (Levo-Dromoran®) required. There is no need for the employment of either the long-lasting anesthetic solutions or d-tubocurarine in oil [11]. Besides failing to control pain effectively in many instances, the anesthetic drugs, like other caustic agents such as phenol or alcohol, cause neurolysis and may produce untoward reactions such as serious necrosis, suppuration or incontinence in some cases. Curare is also a potential danger. By producing generalized muscular relaxation and impairment of muscle control, injection of d-tubocurarine interferes with early ambulation of the patient and adds new problems to the already overburdened and critically short-trained nursing personnel. These calculated risks are decidedly unjustified. The discreet surgeon avoids the use of these drugs as the severity of the pain does not depend on the use or non-use of these agents. Furthermore, these drugs are poor substitutes for the refinements of technic or gentleness in handling tissue during operation; at best these agents are therapeutic crutches fostering a false sense of security and dependence on a drug [4,11].

The patient is ambulated within six to twelve hours after operation. Hot sitz baths are started within twelve to twenty-four hours; moist compresses to the wound have been abandoned. A full regular diet with inclusion of two ripe bananas daily is offered to the patient within less than twelve hours. For patients with concomitant chronic constipation (whether of conviction or fact), a program of bowel re-education which consists of reassurance, an adequately and nutritionally well balanced diet and the administration of liquid petrolatum or a psyllium seed preparation of hydrophilic colloid is begun.

Recently dioctyl sodium sulfosuccinate U.S.P. (bis[2-ethylhexy]sodium sulfosuccinate[colace]) has become commercially available and is the agent of choice. The administration of this compound may be started either twelve hours before operation or thirty-six hours before admission to the hospital. Ordinarily administration is begun six to twelve hours after conclusion of the operative procedure or just as soon as the patient begins to drink fluids liberally. The present dosage is a total of 300 mg. per twenty-four hours, preferably given in three equally divided doses at eight-hour intervals with a full glass of water or other liquid. More recently I have utilized celginace (a combination of colace and alginates).

In the vast majority of patients under fifty-one years of age, a bowel movement of normal fecal bulk occurs within thirty-six to seventy-two hours. The need for continuation of dioctyl sodium sulfosuccinate is established on an individual basis. In this age group of patients, dioctyl sodium sulfosuccinate or celginace has almost replaced liquid petrolatum [12].

For older patients as well as for those habituated to cathartics, a stimulating laxative is required. Peri-Colace,® a combination of 30 mg. of glycosides of cascara sagrada (peristim) with 100 mg. of dioctyl sodium sulfosuccinate in a dosage of one to three capsules is prescribed. The need for Peri-Colace is also established individually for each patient. More recently I have utilized Combinace (a combination of Peri-Colace with aginates).

Digital examinations are begun between the fifth and seventh postoperative days when the

wounds begin to epithelize. In the past these were repeated about every five days in order to promote healing of the wound from the bottom out, thus avoiding bridging which may result in the formation of superficial fistulous tracts. The lubricant used, usually a water-soluble gum, should be bland and free of anesthetic drugs because they are frequently cutaneous sensitizers and cause annoying anoperianal dermatitis. Recent personal studies have revealed that neither the aforementioned conventional nor more frequent digital examinations, nor the topical application of ointments containing cod liver oil, vitamins A and D, chlorophyll, hydroxyquinoline and ethyl benzoate expedited the healing of anorectal wounds, showing that these substances apparently lack the alleged enhanced healing or tissue-growth promoting qualities; natural healing of the wounds always proceeds at a maximum rate. As a result of these observations the frequency of postoperative digital exploration of the wounds has been drastically reduced (two or three examinations for the entire convalescent period) [*13*].

Every mature surgeon knows that the healing of surgical wounds anywhere in the body may be delayed but cannot be expedited. Parenthetically, frequent manipulation of the anal region, which is an erogenous zone, by the surgeon or the patient may create a psychosexual problem or danger in some patients.

Recently, an 0.1 per cent concentration of a new compound N,N′-bis [1-methyl-3-(2,2,6-trimethylcyclohexyl)propyl]-N,N′-dimethyl-1,6-hexanediamine bis (methochloride) hemihydrate (Triburon®) in a carbowax base was accorded a clinical trial in the care of clean as well as infected surgical anorectal wounds. In twenty-five hemorrhoidectomies, compared with twenty-five controls, this substance neither expedited nor interfered with the healing of these wounds. Following drainage and unroofing of periano-perirectal abscesses in eighteen patients and sacrococcygeal suppurations in five patients, the topical use of this substance resulted in cleaner appearing wounds without appreciably shortening the time for effective healing. The same was observed in the healing of the wounds following fistulectomy and fissurectomy in nine and nineteen patients, respectively. This substance also appears to be a good lubricant for postoperative anal explorations, and may be used as a safe substitute for the still prevalently used anesthetic drugs which may cause local deleterious effects in many cases [*14*].

To date, hypersensitivity reactions (being mindful of their occurrence after the use of new drugs) have not been encountered in this group of surgically treated patients, which includes a number of wounds with large raw or vascular areas. Untoward local or systemic reactions have not been observed also in twenty-six patients with perianal cutaneous bacterial infections (pyoderma, furunculosis, folliculitis, etc.) with or without associated pruritus, in five persons with monilial and in seven persons with antibiotic (staphylococcal) pruritus in whom this new therapeutic agent appeared effective. Work on this project is progressing.

Usually postoperative complications do not occur after a properly performed non-traumatizing, open type hemorrhoidectomy. Continued bleeding after operation may demand examination of the wounds with the patient under inhalation anesthesia. The complications, secondary or delayed bleeding (usually following the inclusion of large amounts of tissue in the ligature), impaction, suppuration, painful and unhealing wounds, stenosis and a patulous anal canal, are not common following the performance of the open type of hemorrhoidectomy.

Parenthetically, since cancer may occur in association with postoperative anal stenosis [*15*], it should be corrected by means of a fairly simple plastic procedure [*16*] without undue procrastination.

RECURRENCE

Recurrence of hemorrhoids following a well performed hemorrhoidectomy may be the result of incomplete removal of the primary varices which is preventable, or the inevitable result of the enlargement (with the passage of time) of the secondary hemorrhoidal varices that were inconspicuous at the time of the original operation. I believe that the latter cause comes into play more often than is usually appreciated; absence of proof for this contention at the time of writing is no proof of its absence.

PROBLEM PATIENTS

Ten per cent of patients are either borderline problems or have concomitant systemic disease which justifies a trial of non-surgical therapy. However, a study of over 100 patients with systemic disease on whom I eventually performed hemorrhoidectomies following unsuc-

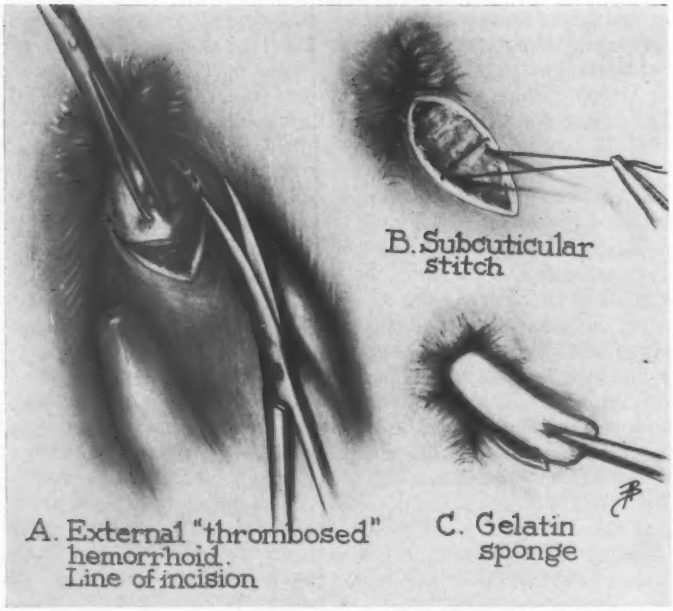


FIG. 8. Technic of external thrombosed hemorrhoidectomy (perianal hematoma). (FROM: TURELL, R. Diseases of the Colon and Anorectum. Philadelphia, 1959. W. B. Saunders Co.)

cessful injectional sclerotherapy has convinced me as well as the patients of the superiority of surgery when clear-cut local indications for hemorrhoidectomy exist. This conclusion was reinforced after treating by injection a still larger number of intelligent patients with mixed hemorrhoids, who for business reasons were unable to undergo hemorrhoidectomy at the time of their initial consultation. All these patients expressed their preference for the operation. The alleged beneficial effects of orally administered "active decongestive therapy" ("the dignified manner of administration") remain to be proved [*17*].

COMPLICATED HEMORRHOIDS

I have successfully treated by immediate operation more than 125 patients with either acutely inflamed, ulcerated, thrombosed, prolapsing hemorrhoids or irreducible strangulated internal hemorrhoids associated with marked swelling of the external components and spasm of the anal sphincter muscles. This surgical approach is instituted if the patient is seen early, that is, before the anatomic landmarks are markedly obscured by edema and the tissues become too friable for easy handling and safe suturing. Early operation eliminates protracted pain and restores the patients to early economic usefulness. Antibiotic therapy may be combined with operation as an additional safeguard against the remote possibility of the occurrence of pylephlebitis. I have practiced early operation for over fifteen years with the full knowledge that other surgeons prefer conservative therapy and delayed operation.

PERIANAL HEMATOMA

If the swelling is small to medium in size and soft, it usually responds to conservative treatment. If it is large or hard, I prefer to excise the mass through an elliptic incision, removing all the overlying skin. (Fig. 8.) Mere incision and evacuation of clots is an inferior operation since clots may re-form promptly. The conservatively treated lesion invariably terminates in tabs or tags which seldom need surgical removal. These are excised in patients with cancerphobia or when the patient believes that they interfere with postdefecatory hygiene. Parenthetically, all tissue or specimens removed at operation should be subjected to histologic examinations.

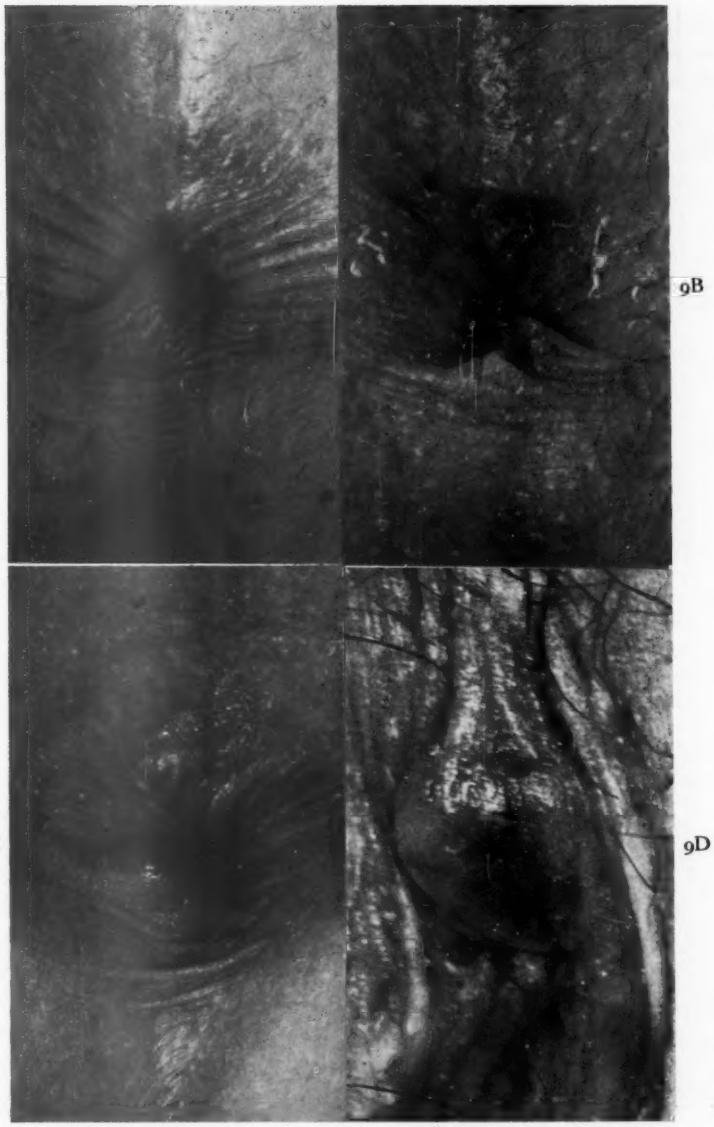


FIG. 9. Hemorrhoids in four juvenile patients. (B) shows internal bleeding hemorrhoids in a six year old child with a pronounced iron deficiency anemia. (FROM: TURELL, R. Diseases of the Colon and Anorectum. Philadelphia, 1959. W. B. Saunders Co.)

Seven cases of unsuspected melanoma have thus been detected.

PEDIATRIC ASPECTS

True internal hemorrhoids are believed to occur infrequently in children (Fig. 9), while the occurrence of perianal hematomas and tags is quite common. However, on occasion I have seen severe bleeding from internal hemorrhoids in children. Many juvenile patients suffer from iron deficiency anemias, which in turn are the result of slow or chronic bleeding caused by internal hemorrhoids frequently overlooked or undiagnosed, a clinical picture that is often seen in adults [*18*].

GERIATRIC ASPECTS

Effective surgical treatment is frequently denied patients primarily because of their advancing age. However it is now realized that age *per se* is no contraindication to operative intervention when clear-cut local indications for operation exist, e.g., recurrent prolapse with bleeding or pain, or frequent episodes of bleeding producing an iron deficiency anemia. Broadly, the indications for operation are similar to those encountered in younger patients. However, strict individualization of every senescent patient is desirable. The main purpose is to add life to the years of these older persons and not necessarily just years to their lives. As a group, they are the most grateful and appreciative patients.

OBSTETRIC ASPECTS

Soft, perianal hematomas (external thrombosed hemorrhoids), regardless of their size, especially in the absence of sphincter muscle spasm, are treated conservatively during pregnancy, primarily by the application of external, moist heat and the oral administration of coal tar derivatives without codeine. Large, painful, hard lesions are best managed by surgical intervention which consists of fairly wide excision of the overlying skin with all thrombi. (Fig. 8.)

Uncomplicated large internal or mixed (internal and external) hemorrhoids are treated palliatively. During the first, and sometimes even the second, trimester bleeding may be controlled by injectional sclerotherapy using phenol in almond oil as a sclerosing agent. On the other hand, complicated internal hemorrhoids (irreducibly prolapsed and/or strangulated) are preferably treated by prompt operation as are similar lesions in non-pregnant women.

During pregnancy, hemorrhoids may make their clinical debut, or those that existed before pregnancy may become aggravated and often are traumatized during delivery. Opinions differ [*19,20*], but I eschew hemorrhoidectomy between pregnancies solely for the purpose of avoiding trouble during future pregnancies. During the reproductive period, I prefer to neglect or inject rather than to resect hemorrhoids.

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DISCUSSION

NEIL W. SWINTON (Boston, Mass.): This is a very comprehensive presentation, and I cannot disagree with anything Dr. Turell said.

I perform these operations very similarly. After the operation I strap the buttocks very tightly with thick gauze, which is removed as soon as the anesthesia begins to wear off. Warm saline dressings are applied to the rectum and changed every hour for eighteen hours. These dressings are very important in reducing postoperative pain.

Large Bowel Obstruction

JOHN J. BYRNE, M.D., *Boston, Massachusetts*

LARGE bowel obstruction has been of surgical interest since Duret, in 1793, performed the first colostomy. Much has been learned about its cause and treatment during the intervening years, especially during the past quarter century when it has been separated from small bowel obstruction. Nevertheless it remains a serious problem, particularly in large municipal hospitals where elderly patients with associated vascular diseases are admitted for terminal care after prolonged obstruction.

EPIDEMIOLOGY

One hundred ninety-seven patients with acute large bowel obstruction admitted to the Boston City Hospital were reviewed for the usual epidemiological features. (Fig. 1.)

Since most of the diseases producing large bowel obstruction occur in elderly patients, there is little wonder that this surgical catastrophe is found predominantly in the older population. In a series presented from New Orleans, 77 per cent of the patients were over fifty years of age [1]. The patients included in the present series are even more elderly, with 94 per cent being over fifty and 48 per cent over seventy. The mortality rises with the decades (Table 1), hence one of the reasons for the high mortality in this group becomes obvious.

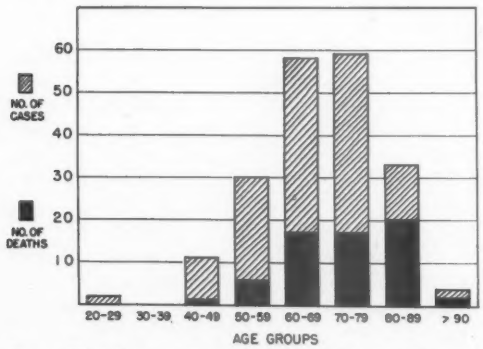

FIG. 1. Distribution of 197 cases of large bowel obstruction, according to age and mortality (98 males, 99 females; 187 white patients, 10 Negroes).

The incidence in Negroes is quite small (5 per cent). This figure is much lower than expected when one considers that during the years 1955 through 1957 the number of Negro patients admitted to this hospital was 8,595 compared to 46,368 white persons, an incidence of 15.4 per cent. A somewhat similar result was found by Becker [2].

DIAGNOSTIC PATTERNS

There were five relatively distinct patterns of symptoms and signs associated with large bowel obstruction. The usual one was the gradual onset of *abdominal distention* associated with severe constipation or *obstipation* (ninety-nine cases). Abdominal hypogastric cramps or vomiting were not prominent and if present occurred late in the disease. Physical examination revealed abdominal distention with normal or increased bowel sounds. The average duration of symptoms was ten days with a range of four to thirty days. Cancer, as expected, was the most common lesion (sixty-seven cases) but surprisingly volvulus, usually a dramatic process, was present in nine patients. The

TABLE 1
DEATHS IN LARGE BOWEL OBSTRUCTION

Age in Decades	Per cent Mortality
20–29	0
30–39	0
40–49	9
50–59	20
60–69	29
70–79	29
80–89	61
90–99	50

emaining lesions were diverticulitis, eight ases; constriction of the suture line, six cases; nd miscellaneous, nine cases. X-ray findings ould be checked in seventy-three patients, and he typical pattern of a distended large bowel with an especially distended cecum was found n forty-three. In thirty patients varying legrees of bowel distention could be seen. Barium enemas were given to sixteen patients (16 per cent). The mortality rate for this group was 28 per cent (twenty-eight patients) with the duration of the disease in fatal cases nine and nine-tenths days, which is almost identical to that for the entire group.

The next most frequent pattern emphasizing *hypogastric crampy pain* with the eventual development of obstipation and distention was found in forty-three patients (22 per cent). The average duration of symptoms was twenty days with a range of four to ninety days. The causative lesions were cancer, thirty-two cases; volvulus, five cases; diverticulitis, two cases; and miscellaneous, four cases. X-ray films showed a pattern of large bowel obstruction in twenty-two patients and a combined large and small bowel pattern in fourteen. As would be expected, the diagnosis was less obvious and barium enemas were given more frequently in this group (seventeen cases, or 40 per cent). The mortality was 25 per cent (eleven cases) with the average duration of obstruction in the fatal cases being twelve days.

Although this obstruction usually develops gradually, in twenty-one patients (10 per cent) symptoms referable to the large bowel developed sufficiently within such a short time that they could be classified as *acute large bowel obstruction*. I am emphasizing large bowel, since the pain was hypogastric and not to be confused with the periumbilical pain of small bowel obstruction. The average duration was one and a half days with a range of one to three days. As expected, more of the offending lesions were acute processes such as intussuscepting or perforating cancer, four; volvulus, six; and diverticulitis, two. Nevertheless, nine patients had lesions of the left colon. X-ray films showed a typical pattern of large bowel obstruction in seven patients and a picture of combined large and small bowel obstruction in two. The mortality was 38 per cent (eight cases).

A past history of *diarrhea* is not uncommon and certainly points to malignancy. However, when it persisted to hospitalization it tended to obscure the diagnosis of obstruction. Such was found in 8 per cent (sixteen cases) with an average duration of symptoms for fourteen days, ranging from one to forty-five days. The usual hypogastric pain, obstipation and distention were present in varying degrees. The lesions were cancer, ten; diverticulitis, two; volvulus, one; and ulcerative colitis, one. The x-ray pattern was typical of large bowel obstruction in seventeen patients and combined large and small bowel obstruction in one. The mechanism for the diarrhea was intussusception in two patients and inflammation in three. The remainder appeared to be due to severe intraluminal pressure since massive distention was present in seven patients, a roentgenographic pattern of a severely dilated large bowel in thirteen and a perforated cecum in two. The mortality rate was 50 per cent (eight cases) and no doubt was related to the severity of the obstruction.

Nine patients (4 per cent) presented periumbilical or generalized abdominal crampy pains which masqueraded as *small bowel obstruction*. The average duration of symptoms was seven and a half days with a range of one to twenty-eight days. The x-ray pattern was typical of small bowel obstruction in three patients, combined small and large bowel obstruction in four, and large bowel obstruction only in one. As would be expected, lesions of the right colon were often at fault (cancer, three and cecal volvulus, one), but lesions of the left colon were just as frequent (cancer, four and fecal impaction, one). The mortality rate was 55 per cent (five cases).

A miscellaneous group of nine patients who had entered the hospital with severe shock, distention or abdominal pain could give no history on admission. Five died (55 per cent) mainly due to the extreme state of obstruction.

CAUSES

The most common disease producing obstruction of the colon was cancer, which was found in 61 per cent (129 cases) of the series with a mortality rate of 30 per cent (thirty-nine cases). The most common location of the cancer was in the sigmoid (seventy cases). (Table II.)

Volvulus was next with twenty-two cases (11 per cent), twelve of which were sigmoidal and ten, ileocecal. The mortality was 22 per cent (five cases).

Diverticulitis caused obstruction in fourteen

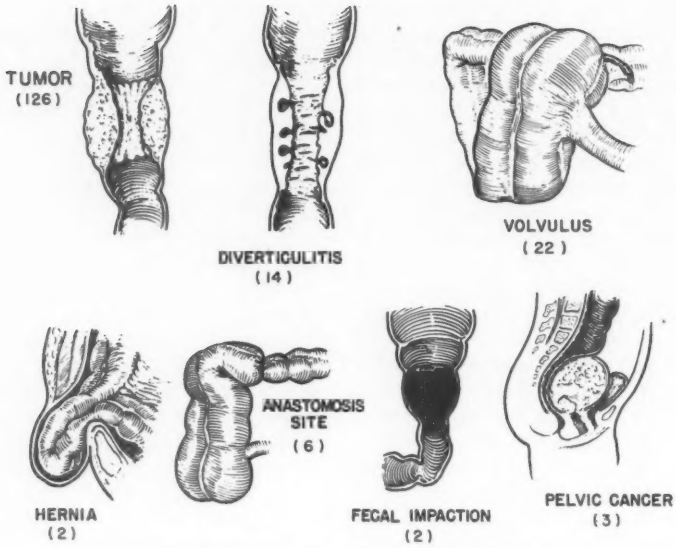

FIG. 2. Causes of large bowel obstruction.

patients (7 per cent) with a mortality of 21 per cent (three deaths).

The remaining lesions varied from fecal impaction to herniation. (Fig. 2 and Table III.)

MECHANISM OF OBSTRUCTION

The occluding type of cancer or diverticulitis is the most obvious cause of obstruction abetted by mucosal edema, muscular spasm or fecal blockage. The twisting of volvulus is the next most frequent mechanism. There are several other processes at work, however, which are of interest.

The *site of anastomosis*, either through edema or constriction, may produce sufficient obstruction to demand operative decompression. Six of these were found: four following closure of a transverse colostomy and two following anastomoses of the sigmoid. The transverse colostomies were closed by resection of the colostomy

TABLE II
CANCER PRODUCING LARGE BOWEL OBSTRUCTION

Site	No. of Cases	No. of Deaths	Per cent Mortality
Cecum	1	0	0
Ascending colon	2	1	50
Hepatic flexure	2	2	100
Transverse colon	8	3	37
Splenic flexure	10	1	10
Descending colon	12	3	25
Sigmoid	70	22	31
Rectosigmoid	15	2	13
Rectum	6	3	50
Endometrium	1	1	100
Ovary	2	1	50
Totals	129	39	30

TABLE III
NON-MALIGNANT LESIONS PRODUCING LARGE BOWEL OBSTRUCTION

Lesion	No. of Cases	No. of Deaths	Per cent Mortality
Volvulus			
Sigmoid	12	4	33
Cecal	10	1	10
Diverticulitis	14	3	21
Suture line	6	1	16
Paralytic ileus	9	4	66
Hernia			
Left inguinal	2	1	50
Feces	2	0	0
Adhesion	1	0	0
Gallstone	1	0	0
Unknown	11	10	91
Totals	68	24	35

FIG. 3. Left colon obstruction due to valve-like action at anastomosis site. X-ray film on *left* demonstrates good filling of left colon with no abnormality noted at the anastomosis. X-ray film on *right* shows evacuation film of barium enema, demonstrating obstruction at the anastomosis.

and end-to-end anastomosis. Edema must have been the cause since they all opened satisfactorily following cecostomy. This emphasizes the fact that closure of a colostomy is not a simple procedure, and care must be taken to perform a good anastomosis, avoiding spurs, kinking and wide inverted cuffs. One case of anastomosis of the sigmoid was interesting in that a barium enema had demonstrated a good anastomosis with no prevention of barium filling. The evacuation film was not observed by the surgeon, since it demonstrated that barium could not pass through the site of anastomosis due to some type of ball-valve mechanism. (Fig. 3.) There were two deaths in this group of patients.

Final obstruction in three patients was precipitated by a gastrointestinal series. Two were mistakenly performed before a barium enema was given to patients with constipation and low abdominal pain, and one was ordered in spite of a barium enema which revealed diverticulitis. The latter patient died.

Intussusception was the final obstructing cause in five patients (transverse colon, one; sigmoid, four).

The most interesting mechanism, from my point of view, was the obstruction precipitated by *a paralytic ileus* which causes a kinking or twisting at a natural flexion point [3]. (Fig. 4.) The causes of the paralytic ileus were pneumonia, four; ulcerative colitis, acute gangrenous cholecystitis, acute bacterial endocarditis, fractured hip and administration of Thorazine.® The twisting or kinking occurred as follows: ascending colon, three; splenic flexure, two; sigmoid as it enters the pelvis, four. The x-ray patterns were typical of large bowel obstruction, and the operating surgeon was always amazed to find no organic disease.

PERFORATION

Perforation of the cecum occurred in thirteen patients with the primary lesions occurring as follows: descending colon, one; rectosigmoid, four; sigmoid, six; ileocecal volvulus, one; and unknown, one. The cause of this perforation is no doubt the increased intraluminal pressure produced by gas and fluid pouring into the colon closed by the competent ileocecal valve. Ten patients had massive abdominal

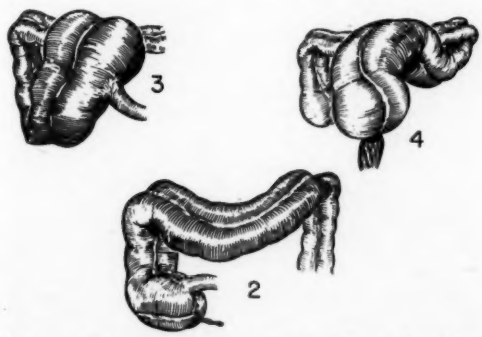

FIG. 4. Sites of large bowel volvulus produced by paralytic ileus: ileocecal (three cases), splenic flexure (two cases) and sigmoid (four cases).

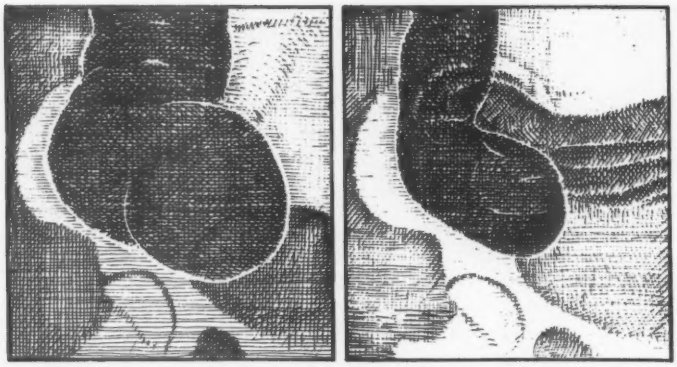

FIG. 5. Drawing of x-ray appearance of colon in cases of perforation. *Left*, cecal perforation usually demonstrates widely dilated cecum. *Right*, perforation at site of cancer usually demonstrates a moderately dilated cecum.

distention and there was marked cecal dilatation in all thirteen. Factors localizing the perforation to the cecum are the thinness of the cecal wall and the large diameter. However, vascular factors must play an important role since the antimesenteric border of the blind cecum must have the poorest blood supply of all the bowel.

Perforation at or near the site of carcinoma occurred in three patients. X-ray films were available in two and revealed a pattern of large and small bowel obstruction.

Besides massive distention, perforation was marked by tenderness in the right lower quadrant or lower abdomen in eight patients and absent or diminished bowel sounds in eight. Pneumoperitoneum was seen in two x-ray films.

The mortality was 25 per cent (four deaths), which is quite lower than usually reported [4].

When can perforation be suspected? As a rule, when the abdominal distention is marked and there is tenderness in the right lower quadrant of the abdomen with absent or diminished bowel sounds, perforation can be diagnosed. If the cecum is markedly dilated there is probably cecal perforation, whereas if the large bowel is only moderately dilated and combined with a pattern of small bowel obstruction on the x-ray film, the perforation is at or near the site of cancer. (Fig. 5.)

ROENTGENOGRAMS

The characteristic flat plate demonstrates that the large bowel is dilated to the point of obstruction with the cecum characteristically prominent. (Fig. 6.) The small bowel is not visualized. In 143 such examinations this was noted in eighty-seven patients (60 per cent). Occasionally it may be obscured by solid or liquid feces. It naturally presupposes an intact ileocecal valve which permits the development of a high intraluminal pressure in the colon predisposing to perforation. Indeed, twelve of thirteen patients with cecal perforations had such a pattern with a markedly dilated cecum. Lowman and Davis [4] studied cecal size in relation to impending perforation, and found that most perforations occur when the cecum is between 9 and 16.5 cm. in size. The usual x-ray sign of perforation is pneumoperitoneum, and the more subtle signs are lack of a psoas shadow and properitoneal fat lines.

In forty-nine patients (34 per cent) additional loops of small bowel could be seen. (Fig. 7.) This does not necessarily indicate ileocecal incompetence. A greatly dilated cecum must place sufficient back pressure on the ileocecal valve and terminal ileum so as to obstruct the oncoming small intestinal gases; an ileocecal volvulus is usually associated with small bowel obstruction; a perforated cecum may give rise to paralytic ileus. One perforated cecum occurred with this combined pattern, but the cecum was markedly dilated and one of the previously mentioned mechanisms may have been responsible.

The ileocecal volvulus has a characteristic appearance of a distended cecum out of its usual position with small bowel usually in the right lower or upper quadrant. (Fig. 8.)

Sigmoid volvulus is similarly characteristic

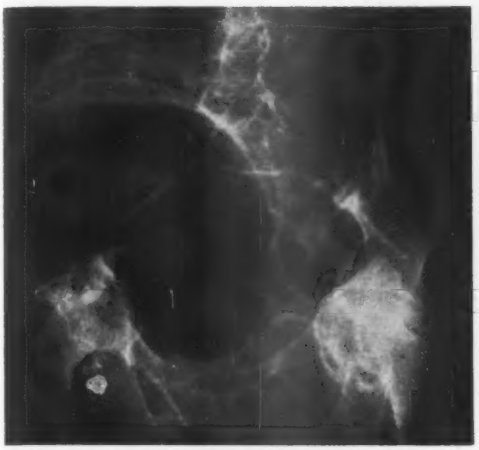

FIG. 6. Flat plate of abdomen in large bowel obstruction demonstrating tremendously dilated cecum.

FIG. 7. Flat plate of abdomen with incompetent ileocecal valve, demonstrating moderately dilated cecum but prominent small bowel pattern.

with a large loop of colon rising out of the pelvis, often reaching toward the diaphragm and curving back to the fixation point of the descending colon in the left upper quadrant. (Fig. 9.) Since this produces a colonic obstruction, the transverse colon and cecum may be dilated.

Barium enemas may be necessary in many patients to delineate the obstructing site more clearly. Care must be taken, however, not to pour too much barium into the distended colon which may be difficult to remove, or to perforate the bowel, giving rise to the dreaded barium peritonitis.

A warning about upper gastrointestinal series should not be necessary.

TREATMENT

The ideal treatment following diagnosis consists of general evaluation of the patient and

FIG. 8. Typical abdominal flat plate appearance of ileocecal volvulus.

FIG. 9. Characteristic abdominal flat plate appearance of sigmoid volvulus.

correction of any remedial defects. *Intubation* is essential to empty the stomach prior to surgery and to prevent the large bowel from becoming more distended by the small intestinal contents. Ulin et al. [5] recently emphasized that the liquid and gas in the large bowel come mainly from the ileum emptying into the cecum, and hence gastric or intestinal intubation may minimize distention of the large bowel. It is also well known that such intubation may lull the surgeon into a false sense of security even in this closed loop type of obstruction. *Water and electrolyte deficiencies* are not as prominent in large as in small bowel obstruction except in late cases when they demand correction. Since neoplasia and cachexia are present in most patients, proper *blood replacement* should be undertaken. The correction of large bowel obstruction is a more difficult task than the subsequent resection of bowel. More awareness of this fact might enable the surgeon to prepare his patient fully for a procedure which is technically simple but often lethal.

Operative decompression should be performed as soon as is commensurate with proper diagnosis and remedy of any metabolic or physiological defects. Seven deaths occurred after delays varying from twelve to sixteen days while the patient was being treated conservatively with intubation and often with antibiotics. I cannot resist quoting some philosophical remarks made by a house officer concerning a seventy-four year old woman who entered the hospital after four days of vomiting with a distended abdomen, absent bowel sounds, generalized rigidity and a fungating rectal mass: "Our duty is to devise ways of making her last days maximum in comfort and dignity." Four days later he stated: " . . . is on Achromycin® with urinary gram-negative infection. All she needs desperately now is to get an intravenous started with tetracycline in it (500 mg. every twelve hours)." The next day a surgical procedure was unsuccessful and she died two days postoperatively.

The proper operation is *proximal decompression* at a spot which will not interfere with the subsequent resection: transverse colostomy or cecostomy in lesions of the left colon and cecostomy in diseases of the right colon or proximal transverse colon. Regardless of the primary location, if the patient is in dire straits, cecostomy may be the simplest procedure. Rarely in lesions of the cecum or ileocecal valve, primary resection or ileotransverse colostomy may be performed, depending upon the patient's condition.

In volvulus the primary lesion must be attacked first, and care must be taken to evaluate the x-ray flat plate and barium enema findings to be sure this disease is not present.

There are several other operative principles which must be maintained. *Exploration should be minimal.* This was grossly neglected in nine patients as evidenced by multiple incisions or long operations, and six died. *The large bowel must be decompressed.* Four patients died, still with obstruction, soon after surgery which did not decompress the bowel at all or did so inadequately through a needle.

Cecostomy was performed by various technics in sixty patients with seventeen deaths (28 per cent). Thirty-six per cent of the lesions were in the left colon and twenty-one in the right or transverse colon. No obvious difference could be found between tube cecostomy or some variety of exteriorizing cecostomy.

My preference is for the tube cecostomy, emphasizing an incision placed directly over the cecum which has been localized by x-ray film and utilizing a wide enough tube (¾ inch) to facilitate decompression. (Fig. 10.) One should not worry about whether or not this will require subsequent closure. Adequate decompression of a large bowel obstruction safely is more important than prevention of a relatively simple operation.

Transverse colostomy was performed upon 119 patients with forty deaths (34 per cent). One hundred ten of the lesions were in the left colon with the remainder unknown.

These figures would tend to favor cecostomy slightly, since a review showed that the general condition of the patients was about the same in both groups. However, the transverse colostomy group was weighted by age, with eighteen deaths occurring in twenty-nine patients over eighty as compared with three deaths in seven patients over eighty in the cecostomy group. Although the latter mortality of 43 per cent appears better than the former 62 per cent in this age group, it is certainly not statistically valid. Still it is conceivable that the technically simpler cecostomy which can be performed with the patient under simple anesthesia might have salvaged more of these aged patients.

There were a few miscellaneous operations.

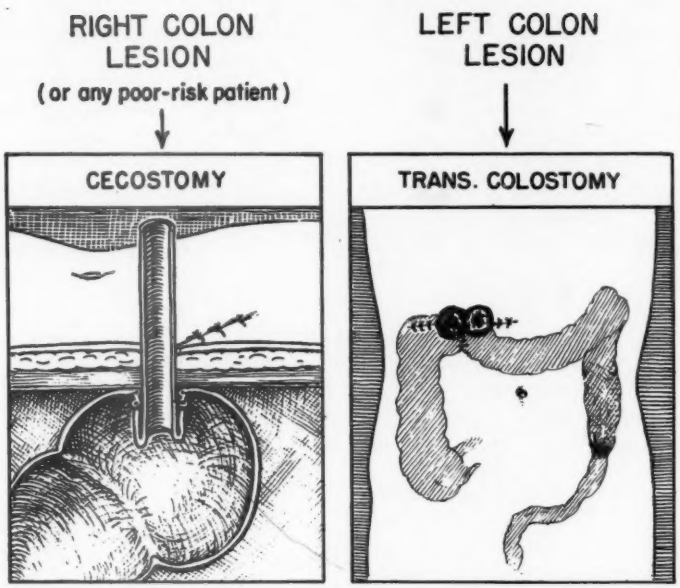

FIG. 10. Types of operative decompression necessary in large bowel obstruction.

Two first-stage Lahey procedures were successful. Two right colectomies and two short-circuiting procedures on the right colon were uneventful. One resection of the left colon with end-to-end anastomosis was a disaster, as expected, and five Mikulicz procedures resulted in two deaths.

Ileocecal volvulus, as we have seen, has a varied history, and diagnosis is usually made by x-ray studies showing the characteristic flat plate or barium enema finding. Detorsion should be made through a right rectus incision. If gangrene is present right colectomy is imperative. Otherwise the cecum is fixed to the right lower quadrant with a tube cecostomy. Nine patients had detorsion with tube cecostomy, and one died. This patient had been admitted with pneumonia and ileocecal volvulus probably developed as a consequence of a paralytic ileus, with death due to septicemia and renal failure. One seventy-nine year old patient had a gangrenous right colon with perforation which was successfully treated by colectomy.

Sigmoid volvulus should be diagnosed by x-ray findings. In the absence of abdominal tenderness or other signs of strangulation, a gentle attempt may be made to decompress this through a sigmoidoscope by inserting a well lubricated soft rubber rectal tube. If successful, elective resection should be performed in three to four weeks. If unsuccessful, laporatomy with detorsion and Mikulicz resection is probably the best choice. Six patients underwent Mikulicz resection; one was a seventy-eight year old woman with decompensation who died of pneumonia one month postoperatively. Two patients with partial volvulus were decompressed retrogradely by transverse colostomy. Two patients underwent operative detorsion and both died subsequently, one of pulmonary embolus and one following a subsequent Mikulicz resection. One death occurred in a patient with severe pneumonia and cyanosis who required tracheotomy even before surgery. Another patient was relieved by enemas and underwent subsequent successful resection.

ANESTHESIA

The choice of anesthesia will depend upon the available anesthetist and the condition of the patient. In general, endotracheal anesthesia is much to be preferred since spinal anesthesia predisposes to shock and may result in higher levels of anesthesia than anticipated in distended patients. Local anesthesia may still be best in the patient who is a very poor risk.

Local anesthesia was used in thirty-one poor-

risk patients with a mortality rate of 39 per cent (twelve cases).

The use of *spinal* anesthesia gave an over-all mortality rate of 29 per cent (ninety-nine cases with twenty-nine deaths) and did not vary much from 25 per cent with cecostomy (thirty-one patients with eight deaths) or 29 per cent in transverse colostomy (fifty-nine patients with seventeen deaths).

Endotracheal anesthesia had an over-all mortality rate of 30 per cent (sixty-three patients with nineteen deaths) and ranged from 20 per cent in cecostomy (fifteen patients and three deaths) to 33 per cent for transverse colostomy (thirty-nine patients and thirteen deaths). Lest it appear that this anesthesia plus cecostomy had the lowest death rate, it should be stated that five of these patients had ileocecal volvulus and no malignancy.

It would thus seem that anesthesia within limits plays no great role in the mortality rate. However, when one reviews the deaths and eliminates obvious blunders, such as resection of the left colon in the face of acute marked obstruction, and then studies them from the point of view of the immediate postoperative mortality, a different picture is presented. There were thirteen such deaths; ten from spinal anesthesia and three from local. The deaths from local anesthesia could probably not have been prevented since the patients were almost moribund, but one aspirated massively and died immediately. Would an endotracheal tube have prevented this? The ten deaths from spinal anesthesia were all fairly similar, manifesting severe drops in blood pressure during the operation with death occurring immediately or within twelve hours following surgery. Thus this reaffirms the opinion that spinal anesthesia is a poor choice in a poor-risk patient with distention.

DEATHS

There were sixty-three deaths in this group of 197 patients, giving a mortality rate of 32 per cent. This is similar to a mortality rate of 32.7 per cent in a group of 205 patients from the Charity Hospital in New Orleans reported by Becker [2]. Some of the responsible factors, such as age, perforation, anesthesia, operative procedures and the diseases predisposing to the paralytic mechanism, have been discussed. It is quite obvious that the reasons for the majority of deaths were prolonged obstruction, advanced state of malignancy or severe associated cardiovascular renal disease. Nevertheless, a different anesthesia or operative procedure might have salvaged about twenty-five patients, which could have given a more creditable mortality rate of 19 per cent.

SUBSEQUENT PROCEDURES

What happened to those patients who survived large bowel obstruction? Only about half came to definitive surgery, and the rest were discharged for terminal care or had benign conditions.

Of the sixty cecostomies, twenty-one patients (35 per cent) came to definitive resection for cancer. Seventeen left colectomies and four abdominoperineal resections were performed with a mortality of 4.7 per cent (one death). Twelve had subsequent closure of the cecostomy.

Thirty-nine per cent of the 119 patients who underwent transverse colostomy had subsequent definitive operations. Thirty-nine left colectomies and seven abdominoperineal resections were performed with a mortality of 6.5 per cent (three cases). Thirty-two had closure of the colostomy with one death.

Thus only about half the patients surviving large bowel obstruction came to definitive surgery, emphasizing again the advanced state of disease and the poor physical condition of this group. It is also incongruous that these major operations have such a low mortality as compared with the simple cecostomy or transverse colostomy. Obviously these patients were better risks since their mortality for the decompressing procedure was zero. However, it could also mean that they were prepared more carefully for their subsequent operation.

SUMMARY

One hundred ninety-seven patients with large bowel obstruction seen in a municipal hospital were reviewed; the mortality rate was 32 per cent. This can be attributed mostly to the elderly age of the patients, the advanced state of malignancy and the duration of the obstruction.

In about half the patients the usual quiet onset of obstipation and constipation was prominent, but in the other half a variety of symptoms were emphasized: hypogastric crampy pain, diarrhea, periumbilical crampy pain and acuteness of onset. The usual lesion

was carcinoma, with the remaining relatively frequent lesions being volvulus and diverticulitis. Of particular interest were a few cases in which the precipitating factor was paralytic ileus producing large bowel obstruction at a natural flexion point such as the right colon, splenic flexure or sigmoid colon.

Perforations could be diagnosed by characteristic physical signs and x-ray findings. The mortality rate of these patients was no different from the rest of the patients, probably emphasizing the value of antibiotics.

The usual x-ray pattern of a dilated large bowel was found in 60 per cent of the patients but in the remainder, varying degrees of small bowel obstruction were seen which confused the diagnosis and required a barium enema for clarification. The typical patterns of ileocecal and sigmoid volvulus were discussed and reviewed. It is emphasized that these should be carefully known by all surgeons, since the treatment of these conditions varies from that of the usual treatment of large bowel obstruction.

The ideal treatment of large bowel obstruction demands careful evaluation of the patient's condition and correction of any metabolic or physiological defect. A proper operation is decompression at a location which will not interfere with subsequent resection. The pros and cons of cecostomy for transverse colostomy are briefly reviewed. There still appears to be a place for cecostomy in the treatment of large bowel obstruction, particularly in lesions of the right colon and in the poor-risk patient. At operation it is also important to explore only minimally and to be sure to decompress.

The best anesthesia for most patients appears to be endotracheal anesthesia. Rarely local anesthesia may be useful in poor-risk patients but care should be taken to prevent aspiration.

The paradox of relatively low mortality in subsequent resections of the colon in patients who survive again emphasizes the severity of large bowel obstruction and the need for better preoperative treatment.

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DISCUSSION

E. Everett O'Neil (Boston, Mass.): At the expense of being repetitious, I would like to emphasize several points that Dr. Byrne touched upon. He included them in his summary but it is quite important to elaborate upon them again.

First, as Dr. Byrne pointed out, it is important that you treat the obstruction as soon as possible. I cannot re-emphasize that enough.

In later years teaching has been in the direction of transverse colostomy in intestinal obstruction due to lesions of the left colon. However, when it is quite obvious that the cecum is distended and you have a poor-risk patient, cecostomy, when performed by the method outlined by Dr. Byrne, is a very excellent method to keep in mind.

The other point I would like to emphasize is that a surgeon should not probe unnecessarily in the presence of large bowel obstruction when he is operating on the large bowel. A "hands off" policy should be adopted. It is not necessary to explore and perhaps cause a perforation.

Charles B. Ripstein (Brooklyn, N. Y.): I enjoyed Dr. Byrne's paper. Certainly the emphasis on the need for urgent treatment of large bowel obstruction is something we should not forget. There has been too great a tendency toward thinking that it is something which can be put off. It is an emergency and requires urgent therapy.

One point I would like to emphasize is the need for a very thorough decompression of the bowel on the operating table. I think it helps these patients tremendously and certainly makes closure of the abdominal wall easier.

I would be horrified to use spinal anesthesia for the reasons mentioned. As the patient comes out of anesthesia he will vomit and aspirate.

I think cecostomy is preferable in the poor-risk patient. I prefer an exteriorizing cecostomy, for sometimes it is easier to keep open than the tube type.

The emphasis on the points that Drs. Byrne and O'Neil have made is very important. I think this high mortality is universal, probably more so than in small bowel obstruction.

Robert Turell (New York, N. Y.): I too enjoyed this very frank discussion because these are the things you usually do not hear about; they wind up in the dead file and no one is the wiser.

In my experience I have found quite frequently that cancer produces gradual obstruction, and a gradual incompetence of the ileocecal valve.

Therefore, the tube does help. However, elderly patients do not tolerate tubes too well since pulmonary complications are apt to develop.

One other thing I would like to emphasize is that many times we get a bit frustrated after performing cecostomy because it does not seem to function right away even though decompression has been done originally. I have found that if irrigation is not begun, within twenty-four or forty-eight hours the cecostomy will begin to function.

DR. O'NEIL: Any other discussion or question?

QUESTION: I wonder if Dr. Byrne divided his cases into those diagnosed as carcinoma and others. It is my impression that the mortality figures are higher for those patients obstructed by malignancy than for others.

I wonder what the mortality figures are for cancer of the left colon as against the right. My impression from resident studies in our hospital in Providence is that the mortality is higher in patients with lesions of the left colon than lesions of the right side.

The point was made that even though small bowel obstruction is more serious, the mortality and results are better than for lesions of the large bowel. I wonder if Dr. Byrne does not think it is because in small bowel obstruction a definitive operation is usually performed. Not only is decompression performed at the time of surgery, which he emphasizes to be important in large bowel obstruction as part of the operation, but also the lesion is removed. In right-sided lesions the removal of the obstructed loop with primary anastomosis has given low mortality rates. The reasoning on my part is that the same may be true for the left side.

DR. BYRNE: I looked up the figures for carcinoma, and there was no particular difference in the mortality rate for this group of patients. In cases of small bowel obstruction we are not dealing with a patient dying of a malignancy as is usual with cases of large colonic obstruction. Obviously you have to have many more figures on your side before you can say that left colectomy is a safe procedure in the face of obstruction.

Unusual Lesions of the Right Colon

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Of the large number of surgical procedures performed on the Third Surgical Service of Boston City Hospital in the course of several years, there are aways certain cases or groups of cases that stand out. Some are those in which a prompt and accurate diagnosis was made, and others are those in which the correct diagnosis was not established until operation.

When the topic of diseases of the colon was selected for this Symposium, there immediately came to mind a group of cases in the second category. These lesions involved the right colon. Some were unusual by their nature, some were unusual in their manifestations. All seemed worthy of presentation because something important was learned from each one.

These cases then, perhaps with one exception, are being presented as surgical problems encountered as routine surgical admissions. One lesson learned is an old one, and I am sure that the Boston University medical students and the Third Surgical Service house staff have heard it "*ad nauseam.*" It is that you cannot make a diagnosis unless you think of it. To the best of my knowledge not one of these diagnoses was made preoperatively. Fortunately, not making the correct diagnosis did not affect the outcome of any case, but I believe all will agree that better handling is obtained when the diagnosis is not a surprise.

Except for brief mention I need not expound on the fundamental difference between the cecum and right colon, and the remainder of the colon [8]. The right half of the colon approximately to the middle of the transverse segment is developed from that portion of the primitive intestinal tube known as the mid-gut. Functionally the cecum resembles a second stomach and the right half of the large bowel simulates, from this standpoint, that portion of the small bowel which develops with it. The true function of the large bowel begins in the transverse colon near the splenic flexure. This development and functional difference not only influence markedly the pathologic type of neoplasm encountered but also alter materially the symptomatology in the two segments.

Of the cases presented herein, there was only one death, and that patient was not operated upon for reasons to be explained later. Ten of these patients were seen by me and seven were handled on the Third Surgical Service as private or service cases.

The first two cases had similar diagnoses. In the first, the correct diagnosis was mentioned as a remote possibility by the radiologist, but carcinoma of the cecum was the firm first choice. In the second case, which was a private case of mine (so I can be critical), not only was the diagnosis not even thought of but also the working diagnosis was in an entirely different organ system.

CASE REPORTS

CASE I. This sixty-six year old man was admitted with a seventeen-hour history of intermittent abdominal pain lasting minutes at a time. Physical examination revealed that the abdomen was not distended. Rectal examination was negative for abnormalities. Laboratory findings were essentially normal. The first barium enema showed a filling defect (Fig. 1) in the cecum, most likely carcinoma. The second barium enema with air contrast study showed "most likely carcinoma of the cecum." Operation revealed a mass in the cecum. (Fig. 2.) Local resection (frozen section) with cecostomy was performed. The pathologic report was mucocele. The lesson learned was that local resection with the help of the frozen section was adequate.

CASE II. This fifty-five year old woman complained of epigastric fulness relieved by belching. This condition was present three to four days, then relieved for three to four days. The patient had undergone hysterectomy and appendectomy

FIG. 1. Case I. X-ray film showing defect in cecum.

FIG. 3. Case II. Specimen of mucocele.

fifteen years previously. Physical examination revealed a slightly protuberant abdomen with a firm, smooth mass deep in the right lower quadrant. Bimanual examination showed a large, smooth, elongated mass about the size of a grapefruit at one end. X-ray study revealed only a small diaphragmatic hernia with mild gastritis and duodenitis. At operation a cystic mass, 15 cm. long by 6 cm. in diameter, was found adherent to the lateral peritoneal reflection and attached to the cecum and appendiceal stump. The pathologic report was mucocele of the appendix. (Fig. 3.) This emphasizes the importance of removing the entire appendix.

FIG. 2. Case I. Specimen of mucocele.

Comment: Mucocele of the appendix is not too often diagnosed preoperatively by x-ray film. Euphrat in 1947 [2] described the following criteria for making the diagnosis: (1) a sharply circumscribed globular or reniform soft tissue mass with considerable mobility but firmly attached to the cecum; (2) medial displacement of the cecum; (3) calcium deposits in the wall or substance of the mass, failure of the appendix to fill with a contrast agent and a vertical appearance of folds of cecal mucosa support, but are not essential to, the diagnosis. This material was quoted only recently by Norberg and Samenius [6], with report of a case.

It is interesting also in this regard [11] that of 43,000 appendices studied at the Mayo Clinic, 136 benign mucoceles and ten mucoceles with grade I adenocarcinoma were found within the cyst. These probably originated in a carcinomatous cystadenoma of the appendix. The next case concerns a lesion in the same general area.

CASE III. This sixty-three year old woman had a two-month history of crampy abdominal pain. Physical examination revealed an obese and lax abdomen. There was tenderness on the right side with a mass about 5 by 7 cm. at the level of the umbilicus. Laboratory findings were within normal limits. Two barium enemas showed a mass in the region of the cecum with no appreciable alteration of the mucosal pattern. (Fig. 4.) At operation a circular submucous lipoma of the ileocecal valve was found. (Fig. 5.)

Comment: The ileocecal area normally contains a considerable amount of fat, and not infrequently unencapsulated or encapsulated fat tissue is accumulated. Lesions are important as they may simulate acute appendicitis,

FIG. 4. Case III. X-ray film showing defect in cecum.

FIG. 5. Case III. Specimen of submucous lipoma at ileocecal valve.

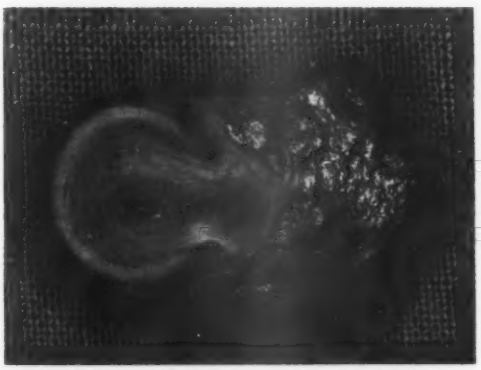

FIG. 6. Case IV. Portion of gross specimen.

FIG. 7. Case IV. Photomicrograph of specimen.

carcinoma of the cecum or ascending colon, or terminal ileitis, and can produce both acute and chronic intussusception and/or intestinal obstruction [4].

Next to adenomatous polyps, submucous lipoma is the most common form of benign tumor of the gastrointestinal tract. Third most common is fibroma. Lipomas occur three times more often in the colon and rectum than in the small bowel. About 324 cases have been reported, of which thirty-two were in the ileocecal region and sixteen in the ileocecal valve. Fifty-five per cent were in females; seventy-nine per cent caused symptoms. Bleeding occurred in only one-fourth of the patients although two-thirds showed ulceration [7,9]. The next two cases represent examples of an inflammatory lesion, one which is common in the large bowel but relatively uncommon in the locations cited.

CASE IV. This forty-two year old dentist had a fifteen-year history of periodic pain in the right upper and lower quadrants, nausea and vomiting. He underwent repeated exhaustive gastrointestinal and genitourinary work-ups. Physical examination showed slight tenderness in the right lower quadrant. X-ray films were negative for abnormalities. Operation revealed a long appendix; the proximal one-third was normal and the distal two-thirds were swollen. (Fig. 6.) There was evidence of recent

FIG. 8. Case v. Specimen showing diverticulum with fecalith.

inflammation. The pathologic report was diverticulosis and diverticulitis of the appendix. (Fig. 7.)

Comment: Diverticula of the vermiform appendix is a rather rare occurrence. According to a study made by Collins [*1*], it occurred in 0.77 per cent of 3,017 consecutive appendectomies and had an incidence of 0.66 per cent in 1,054 consecutive appendices examined postmortem. Seventy-eight per cent are associated with varying degrees of inflammation at the time of their removal. Obviously the diagnosis is not made preoperatively.

CASE V. This fifty-five year old man had pain in the right lower quadrant for thirty-six hours. He passed one loose stool. The pain was sharp and boring; no vomiting occurred. Physical examination revealed pinpoint tenderness in the right lower quadrant with rebound, rectal tenderness on the right. At operation a mass in the cecal wall was biopsied. It was reported as "fatty tissue, no tumor." At second operation a biopsy specimen was reported as "inflammation, no tumor seen." The mass was stony hard. Resection of right colon was performed. The pathologic report was solitary cecal diverticulum with fecalith (the "stony hard mass"). (Fig. 8.)

Comment: Cecal diverticulitis, although rather rare, becomes important in situations such as this. An awareness of it might make it possible to avoid extensive resection and perform a lesser procedure, certainly a sound and worthwhile surgical aim.

The next two cases are, I believe, the most interesting and perhaps the most deceptive.

CASE VI. This forty-seven year old man had undergone repair of a right inguinal hernia two months prior to admission. The patient was admitted with crampy pain in the right lower quadrant, distention, occasional vomiting and diarrhea. He had had two such attacks six and four weeks prior to admission which lasted five to six days. There had been a 10 pound weight loss. Physical examination revealed slight distention, high-pitched hyperactive bowel sounds with rushes, and tenderness in the right lower quadrant. Laboratory findings were within normal limits. An x-ray film (Fig. 9) showed dilated loops of small bowel with air showing fluid levels. Findings at operation were volvulus of the ileum and obstructing carcinoma of

FIG. 9. Case VI. Flat film showing dilated small bowel.

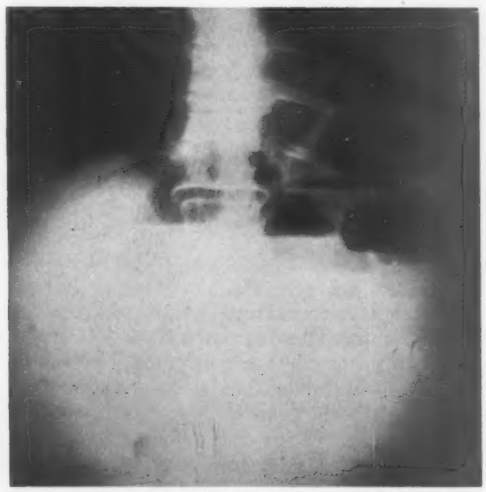

FIG. 10. Case VII. Flat film showing dilated small bowel.

the ascending colon. Right colectomy was performed. The pathologic report was moderately well differentiated adenocarcinoma with invasion into the muscle wall. Twenty-three nodes were negative for disease.

CASE VII. This fifty-nine year old man had an eleven-day history of abdominal pain, gradually increasing distention and vomiting. He had had three normal bowel movements the day prior to admission. Appendectomy had been performed twenty-nine years previously. Physical examination revealed the abdomen to be distended and tympanitic; bowel sounds were hyperactive. No tenderness, masses or hernias were noted. Rectal examination was negative for abnormalities. Laboratory findings were essentially within normal limits. X-ray findings were consistent with small bowel obstruction, probably high. (Fig. 10.) At operation a mass in the cecum was found almost completely occluding the ileocecal valve. Right colectomy was performed.

Comment: These cases point out the advantage of thorough preparation of patients with obstruction for surgery so that definitive surgery can be performed. They emphasize the need for adequate exploration in bowel obstruction, as the lesion in the first patient (Case VI) could have been missed. The relationship of inguinal hernia and unsuspected lesions of the colon, if thought of, might have resulted in an earlier diagnosis in Case VI.

The next two cases represent some of the ever present hazards of making the correct diagnosis of an acute condition of the abdomen. Those with considerable experience know just how hazardous and difficult this can be.

FIG. 11. Case VIII. Flat film of abdomen.

CASE VIII. This sixty-one year old woman was admitted with an eight-month history of cramping epigastric pain with radiation over the entire abdomen. The pain gradually became constant and severe. Findings of the physical examination included marked tenderness in the right upper and lower quadrants, rebound in the right lower quad-

FIG. 12. Case IX. X-ray film showing obstruction at hepatic flexure.

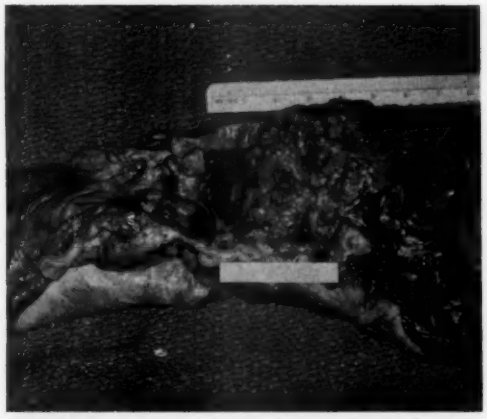

FIG. 13. Case IX. Autopsy specimen of right colon at hepatic flexure showing prune pit.

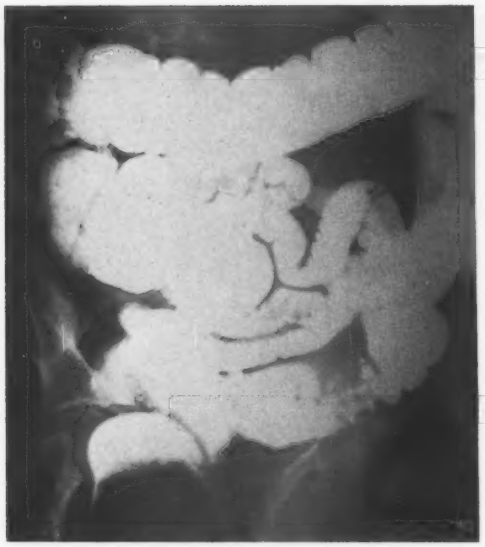

FIG. 14. Case X. X-ray film showing sigmoid lesion only.

FIG. 15. Case XI. X-ray film showing lesions in ascending colon and rectosigmoid.

rant. Peristalsis was normal and active; there was tenderness of the right costovertebral angle. Rectal examination was negative for abnormalities; guaiac test, 4 plus. White blood count was 16,000 per cu. mm.; hematocrit, 31 per cent; 20 to 30 white blood cells in a spun urine. X-ray examination was negative for abnormalities. (Fig. 11.) Operation revealed carcinoma of the cecum extending into mesocolic fat with marked inflammatory reaction. Right colectomy was performed. The pathologic report was "mucinous adenocarcinoma."

FIG. 16. Case XII. X-ray film showing defect in cecum.

CASE IX. This eighty-two year old woman had severe, cramping upper abdominal pain and anorexia of three weeks' duration. Constipation and diarrhea were intermittent. One episode of rectal bleeding was experienced without recurrence. She was afebrile. Physical examination revealed the abdomen to be protuberant and tympanitic with fluid wave. There was moderate tenderness with a freely movable mass in the right upper quadrant about 3 by 2 cm. in size. Peristalsis was normal. Rectal examination was negative for abnormalities; guaiac test, 1 plus. A barium enema showed multiple diverticula in the lower descending colon and sigmoid with some hold-up of flow at the hepatic flexure (Fig. 12), with a question of one or more calculi in the right upper quadrant. The patient gradually weakened and died without operation. At postmortem examination it was found that a prune stone had perforated the right colon at the hepatic flexure. (Fig. 13.)

Comment: Double lesions of the colon are not the rare occurrence they were once thought to be. They can, however, present difficult problems depending upon their nature and more particularly their location. Two cases in point are presented.

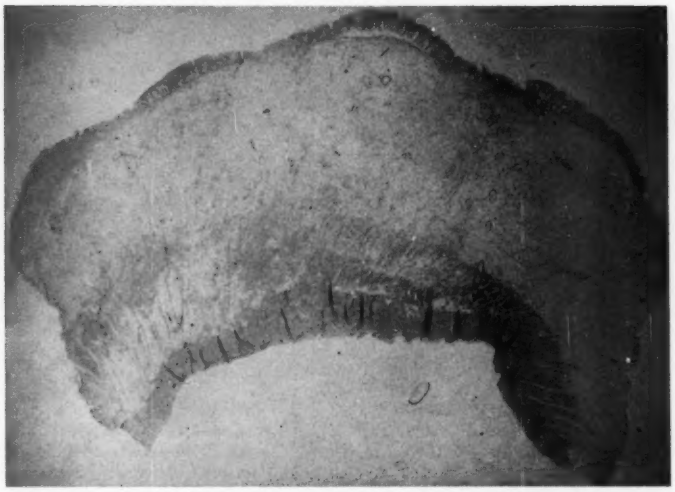

FIG. 17. Case XII. Low power photomicrograph showing thickened cecal wall and mucosal ulcerations.

FIG. 18. Case XII. High power photomicrograph showing amebae in cecal wall.

CASE X. This eighty-two year old woman was admitted with a history of blood in the stool without previous difficulty. At physical examination no significant abnormalities were found. Laboratory findings included anemia; hemoglobin, 7.3 gm. per cent; white blood count, 12,000 per cu. mm. All stools showed a 1 plus guaiac. An x-ray study revealed diverticulitis of the sigmoid and a small reducible hiatal hernia. A repeat barium enema showed superimposed carcinoma. (Fig. 14.) At operation a tense gallbladder filled with stones was found, along with carcinoma of the sigmoid and multiple carcinoma of the cecum. Right colectomy with end-to-end ileotransverse colostomy and resection of the sigmoid with end-to-end anastomosis were performed at one stage. Because of increasing symptoms the gallbladder was removed six months later. The patient is now well.

CASE XI. This fifty-two year old woman had an eight-month history of rectal bleeding. No change in bowel habits or weight loss had been noted. A barium enema showed two lesions (Fig. 15), one in the ascending colon and one in the sigmoid. At operation the lesions were thought to be double carcinoma, and double resection was performed at

FIG. 19. Case XIII. Photograph taken at operation showing bifurcation of taeniae just distal to hepatic flexure.

FIG. 20. Case XIII. Photograph taken at operation showing blind end of reduplicated colon in relation to normal colon just proximal to splenic flexure.

one stage. The pathologic report proved the lesion in the ascending colon to be tubercular, and that in the sigmoid, adenocarcinoma. Again, careful exploration may disclose a lesion missed on x-ray examination.

The next case consisted of enough material for a lengthy discussion. Somehow cases such as this always seem to occur in doctors or their wives.

CASE XII. This fifty-one year old physician's wife had a long history of susceptibility to diarrhea without ever having had a definite diagnosis. When first seen she had a six-week history of diarrhea (ten to twelve movements a day). Bleeding and epigastric distress were occasional occurrences. It was known she had gallstones for many years. She had undergone appendectomy at the age of eleven. Her mother had died of carcinoma. Physical examination revealed no abnormalities. Laboratory findings were as follows: guaiac test, positive; hemoglobin, 13 gm. per cent; white blood count, 12,000 per cu. mm. Barium enema was indicative of carcinoma of the cecum. (Fig. 16.) Amebic disease was considered but x-ray examination indicated surgery. At operation a large thick-walled cecum and ascending colon with immense glands were found. Right colectomy was performed with end-to-end anastomosis. The pathologic report was "amebic colitis with demonstration of amebae." (Figs. 17 and 18.) The patient had a complicated course: bloody stools, low total protein, low prothrombin, icterus, high fever, amebae in stools, pneumoperitoneum and a fecal fistula. In addition to other appropriate antibiotics, Diodoquin,® neomycin and emetine hydrochloride were administered. The patient finally recovered.

Comment: Amebic granuloma of the large bowel is most common in the cecum, 40.9 per cent; followed by the rectum and anal canal, 26.5 per cent; transverse colon, 9.5 per cent; sigmoid, 5.2 per cent; ascending colon, 3.1 per cent; hepatic flexure, 2.2 per cent; splenic flexure, 2.2 per cent; and descending colon, 1.7 per cent. Thus 46.2 per cent occurs in the right colon. Of the complications mentioned by Goldstein et al. [3], which included exacerbation of colitis, hemorrhage, peritonitis and fecal fistula, this patient had them all plus amebic hepatitis.

By contrast, the last case to be reported was a very satisfactory one.

CASE XIII. This thirty-three year old man was admitted to the hospital in 1944 with pain and a mass in the left upper quadrant. A recent work-up at another hospital had resulted in a diagnosis of segmental megacolon. Physical examination revealed tenderness in the left upper quadrant with an irregular mass. Rectal examination was negative for abnormalities. An x-ray film showed a calcified tumor in the left flank compressing the descending colon, probably retroperitoneal connected with the kidney. Another x-ray film raised a question of a fecalith. At operation a duplication of the transverse colon was found starting at the hepatic flexure and ending in a blind pouch situated under and slightly posterior to the splenic flexure. (Figs. 19 and 20.) It had a separate mesentery and was easily removed. This is the only curiosity in the group and represents a rare case of duplication of the large bowel.

Comment: Van Zwalenburg [*10*] describes two types of duplication of the colon. In the first, the majority of cases were diverticula or duplication of all or part of the large intestine and produced symptoms by their size, obstruction, perforation or bleeding. This type usually has one mesentery or occasionally separate mesenteries. In the second type there is usually duplication of the entire hind gut, urethra and bladder which followed stimulus to twin during embryonic life. This type is usually asymptomatic except when associated with developmental errors such as imperforate anus, failure of development of a septum between the rectum and urogenital sinus, or when some unrelated disease is present. A case similar to the last one presented, except for the patient's age, is reported by Higgins [*5*]. This was in a five year old child in whom the duplicated transverse colon with the blind end ballooned up into the left upper abdomen compressing the stomach. As in our case, there was a common lumen in the proximal segment. However, it differed in that its vascular supply was inseparable from the normal portion of the colon.

Acknowledgment: I am indebted to Dr. James Graham, pathologist at St. Elizabeth's Hospital, Boston, Massachusetts, for permission to use Cases III, V and IX, and for the pathologic data in Case XII.

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Surgical Procedures for Carcinoma of the Left Colon and Rectum, with Five-Year End Results Following Abdominopelvic Dissection of Lymph Nodes

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CERTAIN fundamental principles must be applied in the surgical approach to cancer of the left half of the colon. Optimal exposure is very important and makes it possible for the surgeon to perform adequate excision of the malignant tumor and the tissues or organs to which it must be assumed that metastases have already occurred. Jamieson and Dobson [*1*] in 1907 have shown us the way in their work on the anatomy of the lymphatics of the colon. Clogg [*2*] in 1908 reported the results of his examination of seventy-two patients with cancer of the large intestine, indicating the nodes affected, and outlined the various operative procedures necessary in the different parts of the colon. He particularly emphasized the spread of cancer from the splenic flexure to the nodes at the hilum of the spleen, and the necessity for ligation of the inferior mesenteric artery in cancer of the sigmoid colon. It is only recently that we have rediscovered his annunciations. Moynihan [*3*] not only emphasized the ease with which various segments of the colon could be mobilized, resected and anastomosed but also stressed the importance of invasion of blood vessels and tumor emboli.

The study of cleared operative specimens by Gilchrist and David [*4*], Dukes [*5*], Grinnell [*6*] and Coller and associates [*7*] continued to add more specific data regarding the paths of tumor spread. McKittrick [*8*] has given us a well illustrated and detailed approach to resection of cancer of the colon based upon anatomic knowledge and surgical practibility. Cole [*9*] has stressed the danger of local implantation of exfoliated cancer cells in the suture line of an anastomosis. Brown and Warren [*10*] and more recently Fisher and Turnbull [*11*] have demonstrated cancer cells in the venous return from the cancer-bearing areas.

Experience in the treatment of cancer of the colon, and knowledge of its natural history and routes and means of spread have enabled us to offer the patient a lower rate of mortality and morbidity and, we hope, a greater chance of permanent cure.

For cancer within the distal transverse colon, splenic flexure and the proximal third of the descending colon, there should be essentially the same amount of bowel and mesentery removed. This usually means all of the bowel from the mid-transverse colon to the mid-descending colon. If the carcinoma is near the midline, the middle colic vessels should be ligated at their origin; if within the mid-left transverse colon, removal of the left branch of the middle colic vessel is usually adequate. The margin of lymphatic-bearing structures should consist of the major portion of the transverse mesocolon including the greater omentum. Advanced lesions within this area may require removal of segments or all of the adjacent organs, e.g., the greater curvature of the stomach, tail of the pancreas, spleen and left kidney. When the left colic artery arises near the involved area, it too should be ligated at its origin. Despite this radical removal of tissue, end-to-end anastomosis can usually be effected quite easily. The distal left colon and sigmoid may be mobilized in order to make this possible. It is not essential that the mesentery be closed after anastomosis.

Carcinoma within the distal descending

colon, sigmoid and rectosigmoid requires removal of essentially the same lymphatic-bearing tissues, namely, those about the left colic artery and the inferior mesenteric vein and, for lower lesions, all the branches of the inferior mesenteric artery. Again, adjacent organs should be removed when indicated, particularly the left ovary and the greater omentum. Occult metastases are being found in the ovaries, and in any lesion within the colon which involves the visceral serosa, the omentum must be considered as part of the lymphatic drainage area.

There is no unanimity as to the exact surgical procedure for cancer of the mid-rectum and rectosigmoid areas. However, the treatment of cancer lying in the rectum and distal sigmoid between 6 and 17 cm. from the anal margin has given us the same five-year end results whether resection with restoration of continuity or abdominoperineal resection was performed. Some natural factors rather than the cancer have, in our experience, dictated the procedure. The configuration of the pelvic cavity as well as the concavity of the hollow of the sacrum, whether in the male or female, may influence the procedure of choice. Obesity is always a complicating condition if not a limiting factor. In recent years I have employed proctosigmoidectomy in difficult situations in the obese or elderly patient when, under better circumstances, I would have performed anterior resection with end-to-end anastomosis. The low rectal cancer must be treated by combined abdominoperineal resection of the rectum. A large segment of perianal skin should be excised, and the ischiorectal contents and levator ani muscles should be removed at the lateral bony pelvis. Mobilizing the endopelvic fascia at its most lateral extent during the abdominal phase makes the perineal phase quite simple. No attempt is made to suture the skin and subcutaneous fat. If the perineal phase is radical, there will be no other tissues left to approximate. The pelvic outlet should be allowed to close by granulation and scar tissue. Primary suture of the subcutaneous fat and skin has resulted in a greater incidence of perineal hernias.

A review of our failures following abdominoperineal resection of the rectum revealed that at least half were due to residual cancer within the pelvis. It was anticipated that the Miles type of resection might be modified to include dissection of the lower abdominal and pelvic lymph nodes, and thereby improve our survival rate. This procedure was described in 1950 [*12*].

TABLE 1
RESECTION VERSUS ABDOMINOPELVIC DISSECTION OF LYMPH NODES (544 PATIENTS)

	No. of Patients	Dukes Classification		
		A	B	C
With dissection of nodes.....	122	23	41	58
Without dissection of nodes..	422	96	145	201
Five-year survivors:				
With dissection of nodes...	66	19	24	23
Without dissection of nodes.	207	69	92	46
Five-year survival rate (%):				
With dissection of nodes...	54	83	58	40
Without dissection of nodes.	46	72	58	23

Abdominopelvic dissection of lymph nodes consists of excision of lymph node–bearing tissues from the para-aortic and vena caval regions between the ureters from the duodenum down to the levator ani muscles, including the presacral, common, external and internal iliac, and the obturator spaces. In females, bilateral salpingo-oophorectomy is performed routinely. This dissection has been performed in conjunction with either a Miles abdominoperineal resection or anterior resection of the distal sigmoid and upper rectum [*13*].

Blood loss at operation was much greater than that encountered with standard resections, and patients required transfusions averaging 4 to 5 pints of blood. Hospitalization was prolonged seven to ten days. Major urinary complications occurred more frequently, and some degree of bladder dysfunction occurred in all our patients. Of the 122 patients in whom extramesenteric nodes were removed, there were three postoperative deaths, an operative mortality rate of less than 3 per cent.

Analysis of the five-year survival rate (Table 1) shows that it was 8 per cent higher in patients who underwent dissection of nodes than in those on whom this procedure was not performed. This difference is not statistically significant. Table 1 also indicates a survival rate 11 per cent higher in patients with Dukes C lesions. This contrast in a small series is of borderline significance. Metastases to the ovaries, some of which were occult in character, were a significant finding (8 per cent) in this series of patients.

TABLE II
ADDITIONAL FINDINGS IN 122 PATIENTS UNDERGOING ABDOMINOPELVIC DISSECTION OF LYMPH NODES

	No. of Patients and Incidence	Dukes Classification		
		A	B	C
Metastases to extramesenteric nodes	11	1	0	10
Incidence (%)	9	4		17
No. of females: 63		15	20	28
Ovarian metastases	5	0	0	5
Incidence (%)	8	0	0	18

(Table II.) In twenty-eight females with Dukes C lesions, 18 per cent had ovarian metastases. One patient having bilateral ovarian metastases lived for more than seven years before dying of disseminated cancer.

Inasmuch as this investigation was motivated by an attempt to improve the survival rate of patients by decreasing the incidence of residual carcinoma within the pelvis, we must admit that our effort has failed. This is demonstrated by an incidence of 60 per cent of residual cancer in the pelves of those failures we were able to study satisfactorily. However, this study has revealed a significant finding of ovarian metastases in the presence of advanced disease, and their removal has added substantially to the palliation of the patient. Also, in the younger patient, perhaps some degree of extended palliation can be achieved if only more macroscopic disease is removed. At this point in our study, I do not feel justified in urging general adoption of this additional dissection as a supplement to the usual procedures employed in the treatment of carcinoma of the rectum and the distal portion of the sigmoid colon.

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DISCUSSION

NEIL W. SWINTON (Boston, Mass.): The subject of ovarian metastases interests me. I treated two patients in whom, on second exploration, I deeply regretted not having removed the ovaries the first time. There will be some figures printed next year by Shields Warren's laboratory on twenty-one years' experience with this disease. It is a tremendous series. As I recall, his postmortem examinations show about 3 per cent ovarian involvement.

I am sure Dr. Deddish is right about the extent of dissection of lymph nodes with the lesions. I think there is much speculation on the true story of invasion of the blood vessels. A great deal of publicity has been given to it, which Dr. Deddish commented on briefly. However, our series, which now involves over 1,700 patients seen from 1945 to 1953 showed the exact same five-year survival rate (about 44 per cent) whether or not the specimens revealed invasion of blood vessels. It is known that certain tumors in experimental animals shed their cells all the time, yet very few show metastasis unless inundated.

JOHN J. BYRNE (Boston, Mass.): I wonder if Dr. Deddish would comment on recurrence at the suture line?

DR. DEDDISH: In our series we have had a 6 per cent rate of recurrence at the suture line. However, there is some question about three cases, which we believe came from the pelvic wall into the area of anastomosis. One we are very sure of. I saw a small nodule on the site of the anastomosis and resected it. It is now four years later and the patient is still well, so I am sure it was an implant.

We have found more implants in grade III and IV

lesions than in the more benign tumors. I do not know whether it is due to shedding or distal lymphatic infiltration.

When we started our series we tried to get 6 cm. below the primary lesion but this is difficult to ascertain.

QUESTION: How many cases of recurrent cancer or polyps have you seen?

DR. DEDDISH: Our cases of recurrent cancer run about 8 per cent, I believe. The incidence of polyps is about 50 per cent in our specimens.

QUESTION: I would like to ask if you have been using solutions like chloropactin?

DR. DEDDISH: I have not used it in my series. I have been swabbing areas to be anastomosed with tincture of Merthiolate.®

Surgical Treatment of Diverticulitis of the Sigmoid

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IN a recent discussion of the natural history of diverticulosis of the colon, Horner [1] has presented statistics that are pertinent to the problem of diverticulitis. He has divided 503 cases of diverticulosis according to the segments of the colon which were implicated. Table I indicates that the most commonly involved segment was the sigmoid (95 per cent).

TABLE I*
DIVERTICULOSIS OF COLON

Segments Involved	Per cent of 503 Patients
Sigmoid only	47
Sigmoid and descending	33
Sigmoid, descending and transverse	7
Descending only	2
Entire colon	4
Miscellaneous combinations	1
Per cent having diverticula of sigmoid, 95	

* Tables I through IV from: HORNER, J. L. *Am. J. Digest. Dis.*, 3: 343–350, 1958 [1].

It is therefore not surprising that diverticulitis occurs most frequently in the sigmoid portion of the colon. Over 90 per cent of operations for diverticulitis of the colon are performed because the inflammatory process involves this portion of the large intestine.

A second point of importance is that the more extensive the distribution of diverticula, the higher the incidence of diverticulitis. (Table II.) Thus, when diverticula were confined to the sigmoid only, the subsequent incidence of diverticulitis was 14 per cent. If the descending colon was also involved, the incidence was 17 per cent. When the sigmoid, descending and transverse colon contained diverticula, the subsequent incidence of diverticulitis was 40 per cent. If the entire colon contained diverticula, diverticulitis occurred in 50 per cent. The inflammatory process was in the sigmoid in the vast majority of cases. Further study revealed that the more extensive the diverticulosis, the more numerous the diverticula in the sigmoid. Thus, a relationship between the extent to which the colon is involved by diverticula and the number of diverticula in the sigmoid has been established. The more numerous the diverticula in the sigmoid, the greater the likelihood of the development of diverticulitis. These statistics do not support the viewpoint of some surgeons that more than the sigmoid colon should be removed for diverticulitis of the sigmoid simply because there are diverticula in more proximal segments of the colon.

TABLE II
DIVERTICULOSIS OF COLON

Segments Involved*	Per cent of 503 Patients with Diverticulitis
Sigmoid only	14
Sigmoid and descending	17
Sigmoid, descending and transverse	40
Entire colon	50

* The more extensive the involvement, the more numerous are sigmoid diverticula.

Another interesting finding in Horner's study (Table III) is the relationship between the length of follow up of patients having diverticu-

TABLE III
DIVERTICULOSIS OF COLON

Follow Up (yr.)	No. of Patients	Per cent with Diverticulitis
1–5	300	10
6–10	154	25
11–18	49	37

TABLE IV
DIVERTICULOSIS OF COLON

Age (yr.) When First Seen*	No. of Cases	Per cent with Subsequent Diverticulitis
70–79	77	13
60–69	182	19
50–59	170	14
40–49	53	21
30–39	10	20

* No obvious relationship between age and incidence of diverticulitis.

losis and the subsequent incidence of diverticulitis. In patients followed up for one to five years, the incidence of diverticulitis was 10 per cent. For those followed up for six to ten years it was 25 per cent. The incidence of diverticulitis among patients followed up for eleven to eighteen years was 37 per cent. Finally, Horner found (Table IV) no significant difference in the subsequent incidence of diverticulitis in relation to the age of the patient at the time diverticulosis was first discovered. For patients in the various decades from age thirty to seventy-nine, the incidence varied from 21 to 13 per cent.

In 1942 [2] I reported some experiences with the surgical management of diverticulitis of the sigmoid. This was prior to the days of effective antibiotic- and chemo-therapy. At that time operation was never undertaken except in the case of serious complications such as acute perforation, perforation with localized abscess, fistula formation or obstruction, or because of inability to exclude carcinoma. Planned resection of the sigmoid was not an established surgical procedure. A detailed study revealed that the results of various procedures which did not include removal of the diseased portion of the bowel were unsatisfactory, and that the morbidity and mortality associated with them was high. The results in forty-two cases are summarized in Table V. On the other hand, the results of resection were much better. (Table VI.) The procedure which was found to be the most satisfactory for the management of complicated forms of diverticulitis and which was associated with the lowest morbidity and mortality was planned resection of the sigmoid

TABLE V*
RESULTS OF VARIOUS OPERATIONS (EXCLUDING RESECTION) FOR DIVERTICULITIS OF SIGMOID

Lesion	No. of Cases	Operative Mortality	Results (1–10 yr.)		
			Good	Poor	Late Mortality
Perforated	16	2	5	7	2
Non-perforated (with mass)	26	0	11	12	3
Total	42	2 (5%)	16 (38%)	19 (45%)	5 (12%)

* Tables V through VII from SMITHWICK, R. H. *Ann. Surg.*, 115: 969–985, 1942 [2].

TABLE VI
RESULTS OF RESECTION FOR DIVERTICULITIS OF SIGMOID

Lesion	No. of Cases	Operative Mortality	Results (1–10 yr.)			
			Good	Poor	Late Mortality	Unknown
Complicated: Perforated	10	0	10	0	0	0
Complicated: Non-perforated (with mass)	23	2	17	3	0	1
Total	33	2 (6%)	27 (82%)	3 (9%)	0	1 (3%)

TABLE VII
MORBIDITY AND MORTALITY OF RESECTION FOR DIVERTICULITIS OF SIGMOID

Technic	No. of Cases	Complications		Operative Mortality
		Major	Minor	
Anterior resection (turn out, no anastomosis)	4	4	....	2
Mikulicz procedure	11	3	....	0
End-to-end anastomosis plus cecostomy in one or two stages	6	2	....	0
Total	21	9 (43%)	....	2 (10%)
End-to-end anastomosis plus colostomy in three stages	12		2(17%)	0

TABLE VIII
RESECTION WITH END-TO-END ANASTOMOSIS (THREE STAGES*) FOR DIVERTICULITIS OF SIGMOID

Author	No. of Cases	No. of Deaths	Mortality (%)
Smithwick, 1942 [2]	12	0	0
Welch, Allen and Donaldson, 1953 [3]	65	1	2
Waugh and Walt, 1957 [11]	81	0	0
Total	158	1	0.6

* First stage, right transverse colostomy; second stage, resection; third stage, closure of colostomy.

TABLE IX
RESECTION WITH END-TO-END ANASTOMOSIS (TWO STAGES*) FOR DIVERTICULITIS OF SIGMOID

Author	No. of Cases	No. of Deaths	Mortality (%)
Welch, Allen and Donaldson, 1953 [3]	6	0	0
Smithwick, 1959	2	0	0
Total	8	0	0

* First stage, resection and right transverse colostomy; second stage, closure of colostomy.

with end-to-end anastomosis in three stages. (Table VII.) First, a right transverse loop colostomy was performed. After an interval of three to six months, the sigmoid was resected. This was followed by closure of the colostomy in the course of two or three weeks in most instances. This method of management has been generally accepted, and my own personal experiences in more recent years lead me to believe that it is the method of choice in the management of the complicated forms of the disease. My early experiences, as well as more recent ones, indicate that it is not necessary to remove more than the sigmoid portion of the colon to cure diverticulitis of the sigmoid. The objective should be to remove virtually the entire sigmoid, anastomosing the descending colon to the rectosigmoid just proximal to the peritoneal reflection. On the other hand, if only a portion of the sigmoid is removed, recurrences may take place. One must also guard against anastomosis in inflamed or narrowed bowel as strictures may result necessitating further surgery. So far as colostomies are concerned, a simple loop colostomy, opening the anterior wall in a transverse manner, is entirely adequate for proximal decompression. Complete diversion is unnecessary and complicates closure, which is a simple matter in the case of the loop colostomy. Another basic principle is that a proximal colostomy, once made because of a complicated form of diverticulitis of the sigmoid, should never be closed until the diseased bowel has been removed. Recurrence of the inflammatory process occurs in a large percentage of cases following closure of the colostomy without resection [2]. These and many other important points need to be emphasized and re-emphasized for the benefit of those who are accumulating experience with this problem. Most surgeons will be confronted with these cases rather infrequently.

In recent years, many surgeons [3–7] have advocated earlier operation, performed under circumstances when the sigmoid can be resected at the initial operation, preferably without an accompanying colostomy [8–12]. The latter would require a second stage for its closure. Many one-stage resections have been performed in recent years, utilizing antibiotics for preoperative preparation of the bowel and

TABLE X
RESECTION WITH END-TO-END ANASTOMOSIS (ONE STAGE*) FOR DIVERTICULITIS OF SIGMOID

Author	No. of Cases	No. of Deaths	Mortality (%)
Welch, Allen and Donaldson, 1953 [3]	40	2	5
Moore and Kirksey, 1954 [4]	12	0	0
Colcock, 1956 [6]	23	0	0
McCune, Irvine and Miller, 1957 [7]	25	1	4
Waugh and Walt, 1957 [9]	93	1	1
Total	193	4	2

* Proximal decompression, i.e., gastric or intestinal intubation or cecostomy.

in the postoperative period as well. As a rule the only proximal form of decompression used is gastric or intestinal intubation. Cecostomy is used infrequently, being more commonly reserved for relief of obstruction at the site of anastomosis, should it occur. In Tables VIII, IX and X some statistics are given for three- and two-stage resections, and also for one-stage resections of the sigmoid with end-to-end anastomosis. These are taken from representative papers in the surgical literature. It is apparent that three- and one-stage resections are employed most frequently. The two-stage operation seems to have less appeal, although there is much to be said in favor of it. The mortality rate is low for all three, being lowest for the three- and two-stage operations. This is of interest considering the severity of the disease and the complexity of the cases in which three-stage resections are performed. These statistics may not be an incentive to internists and gastroenterologists to advise resection in an earlier stage of the disease.

I have reviewed the last thirty patients operated upon for diverticulitis of the sigmoid at the Massachusetts Memorial Hospitals. During the same period 100 other patients were hospitalized for diverticulitis of the sigmoid and were treated medically. Thus 23 per cent were treated surgically, which is the approximate figure quoted in current surgical literature. The operations performed upon these thirty patients are summarized in Table XI. There was no operative mortality. More details of each case

TABLE XI
DIVERTICULITIS OF SIGMOID

Operation	No. of Cases*	No. of Deaths	Mortality
Resection of sigmoid with end-to-end anastomosis:			
Three stages	17†	0	0
Two stages	2	0	0
One stage	5	0	0
Preliminary colostomy:			
Subtotal colectomy with ilioproctostomy	1	0	0
Excision of left transverse and descending colon, sigmoid and rectum	1	0	0
Mikulicz resection	1	0	0
Colostomy only	3	0	0
Total	30	0	0

* Massachusetts Memorial Hospitals, 1959.
† Descending colon also removed in one case.

are given in Tables XII, XIII, and XIV, and comments on each of these tables are contained in the accompanying footnotes.

Although there were no deaths, a number of complications occurred; I believe some cases should have been managed differently. I will comment briefly on certain of these in order to emphasize what seems to me to be important.

THREE-STAGE RESECTIONS

Seventeen patients were subjected to a three-stage operation. (Table XII.) After reviewing the operative notes I am convinced that staged procedures were indicated and that no experienced surgeon would have attempted resection at the initial operation in any of these patients. Thus, over half of the thirty patients had the most complicated forms of diverticulitis. It is obvious from the histories and from previous x-ray films that at least four patients could and should have been operated upon sooner. These patients had histories of repeated attacks of diverticulitis over a period of three to six years, and one had undergone previous laparotomy for perforation of the sigmoid. In my opinion, that should always indicate a planned three-stage resection of the sigmoid. If one accepts the fundamental principle that the sigmoid should be removed, it becomes apparent that no type of exteriorizing maneuver can accomplish this purpose. There is

TABLE XII

THREE-STAGE RESECTION OF SIGMOID

Patient's Initials and Hospital No.	Age (yr.) and Sex	Duration of Symptoms	Lesion	Time Interval		Complications	Polyps	Carcinoma	Length of Specimen (cm.)
				Colostomy to Resection	Resection to Closure of Colostomy				
B. C. (386,488)	74,F	5 yr.	Inflammatory mass	2½ mo.	5 wk.	.....	...	...	15
E. V. (377,822)	67,M	3 yr.	Perforation of sigmoid, localized abscess	2 mo.	2 wk.	.....	+	...	22
C. H. (378,290)	65,F	7 mo.	Inflammatory mass, obstruction of rectosigmoid	3½ mo.	6 mo.	Leakage at suture line	...	...	15
G. S. (385,107)	50,M	3 days	Acute perforation, general peritonitis	2½ mo.	2 wk.	.....	...	...	22
D. N. (358,331)	41,M	6 mo.	Sigmoidovesical fistula	5 mo.	5 wk.	.....	...	...	11
A. D. (377,824)	70,F	6½ yr.	Perforation of sigmoid, localized abscess	6 mo.	4 mo.	Leakage at suture line	...	...	19
S. E. (384,66)	53,M	4 wk.	Perforation of sigmoid, localized abscess	2 mo.	3 wk.	.....	...	...	20
A. K. (392,046)	69,F	6 days	Sigmoidovaginal fistula*	6 mo.	3 mo.	.....	...	...	20
M. P. (395,207)	50,F	2 wk.	Inflammatory mass	2½ mo.	1 mo.	.....	+	...	17
L. B. (391,957)	62,F	3 days	Perforation of sigmoid, localized abscess	3 mo.	3 wk.	.....	...	...	20
P. N. (380,401)	51,M	12 days	Perforation of sigmoid, localized abscess	8 mo.	2 wk.	Wound dehiscence	...	...	13
B. H. (392, 883)	72,F	6 wk.	Perforation, sigmoidovaginal fistula	4 mo.	4 wk.	.....	...	...	13
J. L. (391,695)	51,M	6 yr.	Inflammatory mass†	3 mo.	7 wk.	.....	...	...	75‡
S. S. (366,547)	60,F	1 yr.	Inflammatory mass, complete obstruction	2½ mo.	2½ wk.	.....	...	...	22
P. W. (368,250)	52,M	5 days	Acute perforation, general peritonitis	3 mo.	2 mo.	.....	...	...	11
L. S. (377, 148)	69,F	1 yr.	Perforation, sigmoidovaginal fistula	2 mo.	1 mo.	.....	...	+	23
D. H. (366,201)	47,F	3 days	Perforation, localized abscess, obstruction of sigmoid	2 wk.	3 wk.	Stenosis of anastomosis, requiring secondary resection	...	...	29

NOTE: The age range was forty-one to seventy-four years of age. Females predominated. Symptoms were present for from three days to six and a half years. With the exception of the last case, the interval between colostomy and resection was two to eight months and from resection to closure of colostomy, two weeks to six months. Leakage at the suture line occurred in two cases, polyps were present in two and adenocarcinoma in one.

* Previous colostomy with recurrence of fistula after closure.

† Laparotomy for perforated sigmoid five years previously.

‡ Descending colon also resected.

no objection to exteriorizing a freely movable loop of perforated sigmoid, providing one proposes to resect it later and perform end-to-end anastomosis. It is my feeling that a right transverse loop colostomy should always be performed for a free perforation. The latter should be closed, if feasible, with catgut sutures or covered with fat or peritoneum or exteriorized, and the pelvis and wound should be drained. Two of the seventeen patients had free perforations with general peritonitis of three and five days' duration, respectively.

Five patients had perforation of the sigmoid with fistulas. In all, a large inflammatory mass was also present. Occasionally there may be a fistula which is relatively quiescent, arising from the antimesenteric border of the sigmoid, with normal, freely movable bowel above and below with a thin mesentery. Resection can be considered initially under these circumstances. Such a situation is, however, unusual. Proximal colostomy followed by resection in three to six months is indicated in most cases. The colostomy can be closed ten days to three weeks later, providing the anastomosis is proved to be intact as judged by barium enema.

Four patients had a perforation with a large fixed inflammatory mass with abscess formation. In these the need for the three-stage procedure is obvious. It is almost never necessary to drain an abscess if proximal colostomy is performed.

Three patients had a large inflammatory mass without obvious perforation. In these, the mesosigmoid was very thick and edematous, and fixed. In practically all of these cases there

TABLE XIII

Patient's Initials and Hospital No.	Age (yr.) and Sex	Duration of Symptoms	Lesion	Time Interval: Resection to Closure of Colostomy	Complications	Polyps	Carcinoma	Length of Specimen (cm.)
Two-Stage Resection of Sigmoid with End-to-End Anastomosis								
S. M. (390,847)	68,M	2 mo.	Small, hard, freely movable mass; complete obstruction	2 mo.	.....	+	...	40*
H. E. (384,916)	62,M	5 days	Thickened area in mid-sigmoid, freely movable; carcinoma suspected on x-ray examination	3 wk.	.....	...	...	13
One-Stage Resection of Sigmoid with End-to-End Anastomosis								
M. C. (391,695)	57,F	3 mo.	Innocuous-appearing sigmoid; Miller-Abbott tube inserted for proximal decompression	.....	.....	...	...	31
F. N. (500,162)	58,M	2 wk.	Inflammatory mass; localized abscess; complete obstruction; x-ray film thought to reveal carcinoma; left ureter resected and implanted in descending colon; cecostomy	.....	Left hydronephrosis	...	...	14
M. MacP. (388,030)	47,F	6 yr.	Freely movable sigmoid; minimal evidence of diverticulitis; Miller-Abbott tube inserted	.....	.....	...	...	20
W. M. (376,291)	53,M	Asymptomatic	Hard, 4 cm., movable mass felt at time of subtotal gastrectomy for carcinoma	.....	Obstruction requiring cecostomy	...	...	14
M. J. (368,154)	46,F	2 yr.	Small localized inflammatory mass; sigmoid freely movable; Miller-Abbott tube inserted	.....	.....	...	...	22

NOTE: Of the one-stage resections, as indicated in the text, patient M. C. probably did not need operation. Patient F. N. should have had a three-stage resection and patient M. J. a two-stage resection because of diverticulosis at the site of anastomosis.
* Descending colon also resected.

actually is a perforation of a diverticulum posteriorly, walled off by the leaves of the mesentery. Primary resection is contraindicated; the three-stage procedure is indicated.

CANCER VERSUS DIVERTICULITIS

Three patients had complete obstruction. This usually is in the region of the rectosigmoid or the distal sigmoid, as judged by barium enema. Proctoscopy is generally unsatisfactory and negative as far as one can see. Evacuation films after barium enema show a normal mucosa. This is the *bête noir* of the roentgenologist. "Obstruction at the rectosigmoid junction is the verdict. Malignancy cannot be excluded." Thus it is apparent that the roentgenologist is uncertain and so is the surgeon. This uncertainty on the part of these two key figures may lead to ill-advised procedures. Even in the presence of carcinoma, two weeks of thought and preparation is not ill-advised. It is rarely advisable to operate today or tomorrow except for the relief of intestinal obstruction.

The case of patient S. S. (Table XII) is one in point. This sixty year old woman had had repeated attacks of severe crampy lower abdominal pain for one year. Three days prior to admission she had a similar attack associated with nausea, vomiting and abdominal distension. An upright film immediately prior to the performance of right transverse colostomy and a barium enema six weeks later are shown in Figure 1. Obstruction to the retrograde flow of barium is not unusual in diverticulitis of the sigmoid. Clinical obstruction of this degree is more common in the presence of carcinoma. Figure 2 shows a well functioning anastomosis following resection of the sigmoid for diverticulitis and subsequent closure of the colostomy. The interval between colostomy and resection was two and a half months.

Patient D. H. (Table XII) also had complete obstruction at the rectosigmoid demonstrated by barium enema. She had a large inflammatory mass with marked thickening of the mesosigmoid. (Fig. 3.) Transverse colostomy

TABLE XIV

Patient's Initials and Hospital No.	Age (yr.) and Sex	Duration of Symptoms	Lesion	Time Interval: Colostomy to Resection	Complications	Polyps	Carcinoma	Length of Specimen (cm.)
Mikulicz Resection								
G. R. (339,314)	42,F	5 mo.	Orange-sized inflammatory mass in mid-sigmoid; x-ray film showed diverticulosis and diverticulitis of sigmoid; pathologic report, acute diverticulitis	.....	.....	...	...	11
Preliminary Colostomy: Unusual Secondary Resections								
C. C. (383,277)	57,F	3 days	Large adherent inflammatory mass in sigmoid; x-ray film showed diverticula of entire colon and diverticulitis of sigmoid; removal of colon with ileoproctostomy	4 mo.	.....	...	...	80
M. H. (379,633)	70,F	4 yr.	Large adherent inflammatory mass in left lower quadrant; marked narrowing of rectum and sigmoid with spasm and fistula from sigmoid to left iliac fossa; resection of left transverse and descending colon, sigmoid and rectum	5½ mo.	Bronchopneumonia	...	...	57
Colostomy Only								
A. H. (346,840)	58,F	11 mo.	Multiple fistulas and ventral hernia following previous colostomy and closure for acute perforated sigmoid: right transverse colostomy	.....	.....	...	...	...
M. S. (332,373)	71,F	3 mo.	Large inflammatory mass with sigmoidovesical fistula; right transverse colostomy	.....	.....	...	...	...
H. W. (390,847)	76,M	4 days	Large inflammatory mass in sigmoid; diverticulitis of sigmoid with obstruction shown on x-ray film; right transverse colostomy	.....	Postoperative ileus of small bowel	...	...	...

NOTE: Resection with end-to-end anastomosis is preferable to the Mikulicz technic since the latter does not remove sufficient bowel. In patient C. C., colectomy with ileoproctostomy was performed because of generalized diverticulosis. It is not necessary to remove more than the sigmoid under these circumstances, in my opinion. In patient M. H., the rectum was extensively involved and had to be removed. This is very unusual. Continuity of the bowel can nearly always be restored except in this one circumstance. The patients with colostomy only will presumably undergo resection. It is of interest that patient A. H. had undergone previous colostomy for perforation of the sigmoid with subsequent closure and prompt recurrence of the disease (see patient A. K., Table XII). Once colostomy has been performed for a complicated form of diverticulitis of the sigmoid, it should never be closed until this segment of the intestine has been resected.

was performed. Because of the fear of carcinoma, resection was performed two weeks later without repeating the barium enema. As a rule complete obstruction due to diverticulitis will be relieved in the course of two weeks' proximal decompression or intensive medical therapy. The roentgenologist is then usually able to differentiate between inflammation and neoplasm, thus permitting a longer delay before resection is attempted. If in doubt, repeated x-ray films and proctoscopic examinations should be made prior to resection. In this case, removal of the inflammatory mass was difficult. A large abscess cavity was present in the mesosigmoid. The rectosigmoid was inflamed, contracted and edematous with a small lumen. The proximal bowel was dilated. The anastomosis was not satisfactory, and marked stenosis at the suture line resulted. Figure 4 shows the narrowed area immediately after operation and several years later, at which time secondary resection had to be performed.

FIG. 1. Patient S.S. (Table XII.) X-ray film on left taken just prior to transverse colostomy shows marked evidence of intestinal obstruction with fluid levels. X-ray film on right was taken six weeks later, one month prior to resection. It reveals numerous diverticula of the sigmoid with marked spasm.

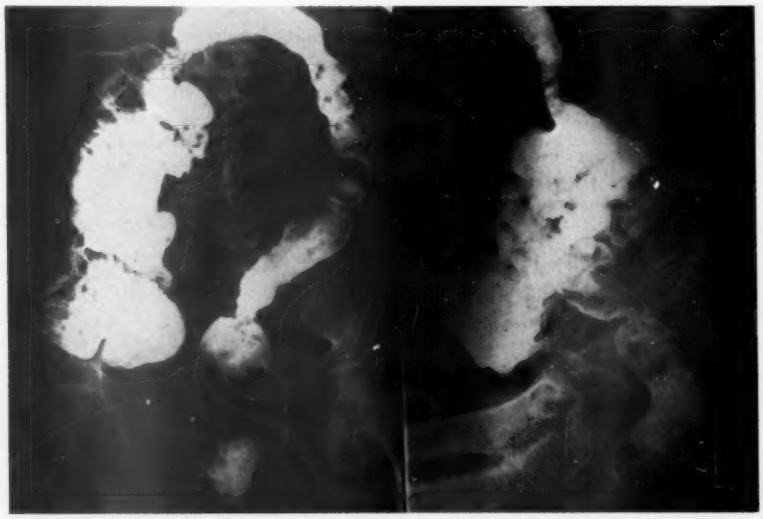

FIG. 2. Patient S. S. (Table XII.) Same patient as Figure 1. Anteroposterior and lateral views following resection of sigmoid and closure of colostomy. Descending colon is anastomosed to rectosigmoid just above peritoneal reflection. There is a well functioning anastomosis.

Roentgenologists are surprisingly accurate in differentiating between diverticulitis and carcinoma when no obstruction exists. Occasionally they make a mistake, as we all do, and carcinoma is overlooked. Patient L. S. (Table XII) is an example of this. The patient had diverticulitis of the sigmoid with perforation and a sigmoidovaginal fistula. The original x-ray examination revealed typical diverticulitis with a fistulous tract with no obstruction, and nothing to suggest malignancy. Unfortunately this film cannot be found. Transverse

FIG. 3. Patient D. H. (Table XII.) Barium enema reveals complete obstruction. Carcinoma could not be excluded. Transverse colostomy was performed followed by resection two weeks later without repeating barium enema. The lesion was benign. In the absence of carcinoma, obstruction due to diverticulitis is usually relieved in the course of two weeks after colostomy, thus permitting the roentgenologist to differentiate between diverticulitis and carcinoma. There should have been a longer delay between colostomy and resection. (See discussion of case in section on "Cancer versus Diverticulitis" and Figure 5.)

colostomy was performed with the intention of waiting three to six months before resection. Ten weeks after the first x-ray examination, a second barium enema was performed. (Fig. 5.) This showed complete obstruction, but the fistula was no longer apparent. No evidence of malignancy was detected, but the presence of increasing evidence of obstruction suggested this possibility. Resection was performed. The specimen showed a perforation of the distal sigmoid with a sinus which communicated with the apex of the vagina. Several centimeters proximal to this was a small obstructing adenocarcinoma. In staged operations, where the interval between colostomy and resection may be several months, it is wise to obtain a barium enema at monthly intervals not only to check on the status of the inflammatory process but also to guard against overlooking carcinoma and too long a delay before removing it. Increasing obstruction after proximal colostomy strongly suggests carcinoma, while relief of complete obstruction after proximal colostomy favors a benign process.

Another important complication to watch for in three-stage operations is leakage at the suture line following removal of the sigmoid with end-to-end anastomosis. In the presence of proximal colostomy, leakage at the suture line is not apparent clinically. Therefore, a barium enema should always be performed before the colostomy is closed. Figure 6 reveals a fistulous

FIG. 4. Patient D. H. (Table XII.) X-ray film on left, taken shortly after resection, shows marked stenosis at site of anastomosis which was performed in the presence of markedly inflamed bowel. X-ray film on right shows stenosis several years later, at which time secondary resection had to be performed.

tract at the site of anastomosis in patient C. H. (Table XII.) The first film was taken ten days after resection and the second two months later, showing virtually complete healing. As a rule the colostomy can be safely closed in the course of two to three months. Closure of the colostomy in the presence of a sizable defect in the suture line may have dire consequences, just as leakage at the suture line may be very serious or even disasterous following one-stage resections with end-to-end anastomosis. (Table XV.) No form of proximal decompression, including cecostomy, gives adequate protection against leakage at the suture line. This matter will be commented upon further in connection with one-stage resections.

TWO-STAGE RESECTIONS

This operation appears to be utilized comparatively infrequently. It was only performed upon two patients in this particular series (S. M. and H. E.). (Table XIII.) In both cases the sigmoid could be readily resected initially. Concomitant transverse colostomy was performed in each instance because of the presence of diverticula in the proximal segment. In one case the descending colon was included in the resection, but diverticula were numerous in the left transverse colon as well. The two-stage maneuver should be performed if there is any question about the anastomosis, i.e., tension, questionable circulation, inflammation or edema of either segment or small lumen. Having a proximal colostomy for a month or so is a small price to pay for absolute protection against a serious or fatal complication. When operating upon patients in the early stage of diverticulitis, especially if they are under fifty years of age, serious complications or deaths must be avoided. It is my impression that this operation should be performed upon many patients now being subjected to the one-stage operation.

ONE-STAGE RESECTIONS

Five patients were subjected to this operation. (Table XIII.) After reviewing the history, operative findings and pathologic report of patient M. C., I question whether surgery was necessary. Patient F. N. had a large adherent inflammatory mass which was resected initially because of complete obstruction, as judged by barium enema. Preliminary transverse colostomy with further x-ray examination in two to three weeks would have undoubtedly revealed the benign nature of the problem. As it was, resection was difficult; the left ureter, being adherent to the mass presumed to be malignant, was resected, and the proximal ureter was transplanted into the descending colon. This resulted in a rather marked hydronephrosis which eventually subsided considerably but was a matter of concern because the patient was found to have a calculus in the pelvis of the right kidney. In patient W. M. obstruction developed at the site of anastomosis, requiring subsequent cecostomy. Patient M. J., a forty-six year old woman with recurrent attacks of severe pain associated with chills and fever over a two-year period, which did not respond to a good medical regimen, was an ideal case for

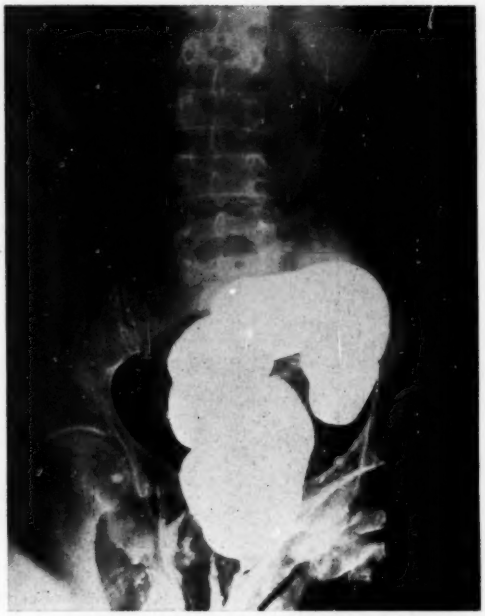

FIG. 5. Patient L. S. (Table XII.) Complete obstruction of sigmoid which was detected after transverse colostomy had been performed for diverticulitis with perforation and a sigmoidovaginal fistula. The original x-ray film taken before colostomy was performed, and ten weeks prior to this film, showed no obstruction and no evidence of carcinoma (film cannot be found). It did show diverticulitis with a fistula. Resection shortly after this film was taken revealed the fistula and an obstructing adenocarcinoma several centimeters proximal to it. Increasing obstruction following colostomy is strongly suggestive of malignancy. For this reason, in three-stage procedures, barium enemas should be performed at monthly intervals so that an unsuspected coincidental carcinoma will not be overlooked and its removal deferred too long. (See Figure 3.)

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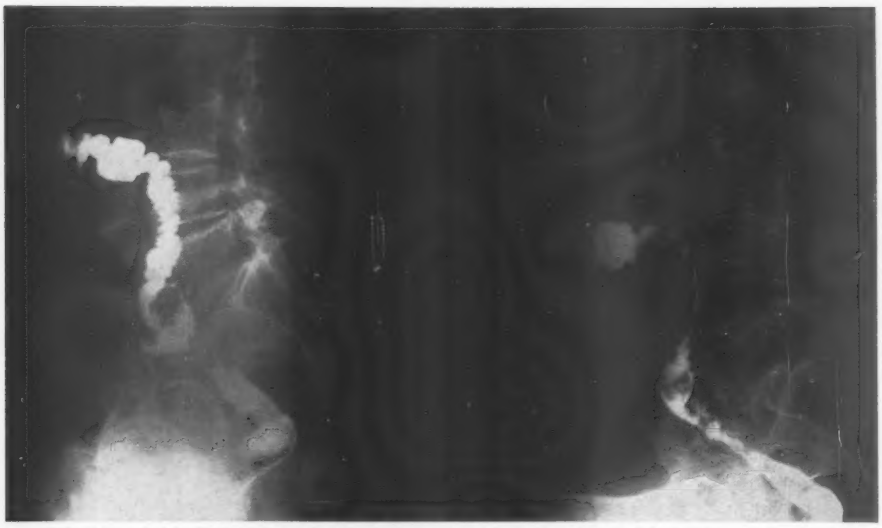

FIG. 6. Patient C. H. (Table XII.) Fistula at suture line is seen in film on left. Barium enema was performed ten days after resection, preparatory to closure of colostomy. There were no clinical signs or symptoms to suggest that leakage had occurred. Barium enema two months later, shown on right, reveals tract is virtually healed. Colostomy should never be closed after resection until the suture line is checked by barium enema. (See Table XV.)

initial resection. She had a small localized inflammatory mass in an otherwise movable sigmoid without inflammation at either end of the resected specimen. The pathologic report revealed acute and chronic diverticulitis. The patient had an uneventful convalescence with a Miller-Abbott tube inserted for proximal decompression. This patient had numerous large diverticula proximal to the resected area and at the site of anastomosis. (Fig. 7.) Under these circumstances I would not consider one-stage resection because of the hazard of leakage from

TABLE XV

LEAKAGE AT SUTURE LINE FOLLOWING RESECTION OF SIGMOID WITH END-TO-END ANASTOMOSIS

Authors	No. of Cases	No. with Leakage	Complications		No. of Deaths
			Minor	Major	
Without proximal colostomy: Smithwick, 1942 [2] Welch, Allen and Donaldson, 1953 [3] Colcock, 1956 [6]	69	6	1	5	2
With proximal colostomy: Smithwick, 1942 [2] Smithwick, 1959	31	4	4	0	0
Total	100	10	5	5	2

NOTE: When leakage occurs following resection of the sigmoid with end-to-end anastomosis, without proximal colostomy, the complications are always apparent clinically, are nearly always serious and may be fatal. On the other hand, if leakage occurs in the presence of proximal colostomy it is not clinically apparent, is detected only because routine barium enemas are obtained before colosure of the colostomy. The usual finding is a small fistula which heals spontaneously in about two months. (Fig. 6.)

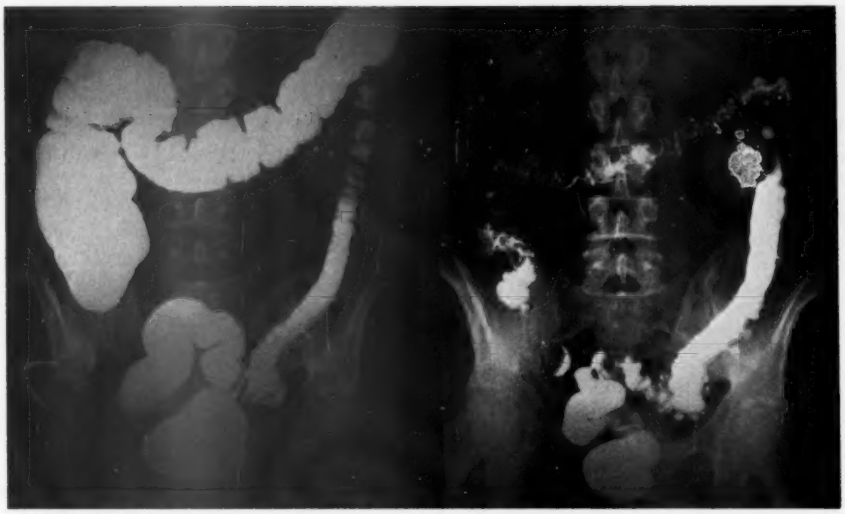

FIG. 7. Patient M. J. (Table XIII.) Two preoperative films of the barium enema are shown. There was no lateral view. This is important since many diverticula project posteriorly and are not shown in anteroposterior views. This patient underwent one-stage resection of the sigmoid and fortunately survived. The anastomosis was performed at a point where diverticula were present. This should never be done, in my opinion. Two-stage resection should have been performed. If a one-stage operation is to be performed under these circumstances, the left transverse colon should be anastomosed to the rectosigmoid. Since resection of diverticula proximal to the sigmoid is not necessary to cure diverticulitis of the sigmoid, extention of the operation in order to make a one-stage resection safe is not justified, in my opinion. A colostomy for one month is a small price to pay for absolute security.

the suture line. Proximal colostomy was indicated, in my opinion, with closure approximately a month later. Thus, in summary, one of these five patients should not have been operated upon. A second should have had a three-stage procedure and a third should have had a two-stage procedure. Ideally, the one-stage operation should be reserved for patients whose problem is confined to the sigmoid, without proximal diverticula, who have had repeated attacks or persistent symptoms not responding to a good medical regimen, and in whom the inflammatory process is such that it does not render resection difficult. Many surgeons believe that age is important and that patients under fifty years of age or having bladder symptoms during attacks or evidence of small bowel obstruction should be seriously considered for surgery. In general, internists and gastroenterologists are very conservative about advising surgery for diverticulitis, and tend to defer operation longer than most surgeons would and, in some instances, much longer than is desirable.

If more patients are to be operated upon in an uncomplicated stage of a benign disease and at a younger age, it is absolutely necessary to eliminate serious complications and any operative mortality related to surgical technic or judgment. This is particularly important since patients with the most complicated forms of the disorder can be operated upon with a very low morbidity and virtually no mortality. (Table VIII.)

The greatest single hazard in dealing with diverticulitis of the sigmoid is leakage at the site of anastomosis. I have gathered a few statistics on this matter. Table XV contains 100 cases and shows the consequences of leakage at the site of anastomosis. They are arranged according to whether or not proximal colostomy was present. The point I want to make is that proximal colostomy gives complete protection against the serious consequences of leakage at the suture line. No other method of proximal decompression does. The consequences of leakage in the absence of proximal colostomy are nearly always serious, necessitating further surgery, and may be fatal. To me, this means that one should think carefully before deciding that proximal

TABLE XVI
DIVERTICULITIS OF SIGMOID

Lesion	Suggested Operation
Complicated:	
Perforated Non-perforated (with mass)	Planned resection of sigmoid in three stages
Uncomplicated:	
	One stage if bowel is easily resectable and normal at site of anastomosis
Recurrent attacks Persistent symptoms Bleeding X-ray deformity ? Carcinoma	Two stages if bowel is easily resectable but diverticula present at site of anastomosis, or if anastomosis unsatisfactory for any reason
	Three stages if lesion is found to be complicated

colostomy need not be performed in conjunction with resection with end-to-end anastomosis for uncomplicated diverticulitis of the sigmoid. This more cautious attitude is apparently favored by some surgeons [*13,14*]. Nothing will dampen the enthusiasm of internists and gastroenterologists for early operation more effectively than a few serious complications or deaths. Suggested indications for one-, two- and three-stage resections are given in Table XVI.

SUMMARY

A number of important principles which should be considered in the management of diverticulitis of the sigmoid have been discussed. If these are observed, even the most complicated forms of the disorder can be cured with a very low morbidity and almost no mortality. Also, carcinoma should be rarely overlooked. More patients should be operated upon earlier, but in many a serious complication develops with symptoms of only a few hours', days', weeks' or months' duration. As larger numbers of patients are operated upon in an uncomplicated stage of the disease, when the sigmoid can be resected initially, it is essential that serious complications or deaths be avoided. The greatest danger is leakage at the suture line. The value of proximal colostomy in protecting against the serious or fatal consequences of this complication are stressed. Indications for the use of one-, two- and three-stage resections are given. The late results following successful resection of the sigmoid for diverticulitis are excellent.

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DISCUSSION

JOHN J. BYRNE (Boston, Mass.): Dr. Smithwick has presented his material clearly and given us a guide for our own cases. I would like to ask him if he believes the sigmoid should always be resected at a point below the peritoneal reflection.

DR. SMITHWICK: No, this is done only in the rare patient with involvement of the rectum. Usually removal of the sigmoid with anastomosis about 1 inch above the reflection is all that is necessary. I have never had a recurrence.

MICHAEL R. DEDDISH (New York, N. Y.): How frequently does bleeding occur, and why?

DR. SMITHWICK: I do not think bleeding is very often a major problem in diverticulitis. It does

occur in about 16 per cent of the cases, with a rare patient exhibiting massive bleeding. I think just as many patients with diverticulosis have massive bleeding due to erosion of an artery by a fecalith. Hemorrhage is not necessarily related to the process unless it is by way of an abscess or fistula, and then a fatal hemorrhage may occur.

CHARLES B. RIPSTEIN (New York, N. Y.): I think Dr. Smithwick has rightly pointed out that we should stick to some of the tried and true principles that he and others have discussed in treating this disease.

In my service we believe such patients need three stages. We have thought that the time involved in closing the colostomy is more than compensated for by the lack of complications.

One other point I would like to make is that in the patient with complications, exploration should be kept to a minimum to prevent the breaking down of abscesses.

End of Symposium on Diseases of the Colon

SCIENTIFIC PAPERS

The Story of Cholecystography

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WARREN H. COLE

ONE day in the early spring of 1923 Dr. Evarts Graham asked me to come to his office to discuss my activities for the following year. At that time Dr. Graham was Professor of Surgery at Washington University, St. Louis, and I was a first-year resident at Barnes Hospital. The residency at Barnes Hospital was a pyramidal one, having four or five first-year residents, three second-year residents and one third-year resident. Needless to say, when I applied for my residency the preceding year I had the keenest desire to be appointed each succeeding year so that I could complete the three-year residency. I had already completed a year of straight surgical internship under Dr. Graham, and the previous year a straight medical internship under Dr. Thomas Boggs at the City Hospital in Baltimore.

When I received this call I immediately thought "there are my walking papers and I am going to be relegated to the bush leagues somewhere." On my way to his office, which in those days was across the street from Barnes Hospital, I did a lot of thinking, wishful thinking it was, trying to justify my reappointment to the second-year residency, even though I knew very well that Dr. Graham's mind was no doubt completely made up about my dismissal, and nothing I could say would change it. All of us knew him as a man of firm conviction who stuck tightly to his ideas, almost to the point of stubborness, unless someone presented very good evidence showing he was wrong. Nevertheless, as I crossed the street I began assembling data which might be used in my behalf. This wishful thinking built up almost to a point of resentment. After all, had I not worked night and day throughout the several months of my residency, leaving the hospital no more than two or three evenings per month? Also, had I not fulfilled Koch's postulate on the undiagnosed patient with systemic blastomycosis, and demonstrated blastomycetes in the lungs of a guinea pig after inoculation of secretions from a patient's skin ulcer? However, by the time I reached his office I was fairly well resigned to my fate.

Dr. Graham's greeting was unusually friendly, and my concern was neutralized, particularly when he said he had a laboratory experiment in mind which he hoped I would be willing to work on full time the following year, beginning July 1. He relieved any remaining apprehension I had by telling me he wanted me to resume my residency the following year.

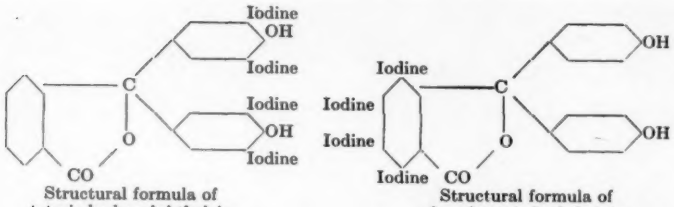


FIG. 1. Structural formula for the halogenated phthaleins. (FROM: GRAHAM, E., COLE, W., COPHER, G. and MOORE, S. Diseases of the Gallbladder and Bile Ducts. Philadelphia, 1928. Lea & Febiger.)

BASIC INFORMATION ALLOWING THE DEVELOPMENT OF CHOLECYSTOGRAPHY

Dr. Graham told me that several years previously (1910) Abel and Rowntree [1] had conducted some extensive pharmacologic experiments on the excretion of several phenolphthalein compounds, and reported that these drugs were excreted for the most part (80 to 90 per cent) by the liver; also, the dye could be found in the gallbladder several hours after ingestion. They started their work originally as a study of cathartics, but their discovery that the dyes were excreted by the liver soon gave rise to a study of certain of these compounds as agents for testing liver function. In 1913 Rowntree, Hurwitz and Bloomfield [2] reported on the use of phenoltetrachlorphthalein as a test for liver function. It was Dr. Graham's idea that if a heavier halogen such as iodine could be attached to the phenolphthalein radical, the bile might be impervious to the x-ray, particularly since Rous and McMaster [3] had shown that the normal gallbaldder concentrates the bile eight to ten times.

EARLY EXPERIMENTAL WORK

Shortly before beginning work on the problem on July 1, 1923, we consulted the Mallinckrodt Chemical Works in St. Louis asking if they could make or supply us with several halogenated phenolphthalein compounds (Fig. 1) for experiments on a mechanism of visualizing the gallbladder. They expressed a keen interest in the problem, and assigned Dr. N. Drake, a chemist in their Research Department, to cooperate with us in the manufacture and procurement of compounds. We had put in a request for tetraiodophenolphthalein but none was immediately available.* While we were waiting for it to arrive we injected sodium phenoltetrachlorphthalein intravenously into some dogs, but did not expect to produce visualization of the gallbladder since the atomic weight of chlorine is only 35.5 compared with 80 for bromine and 127 for iodine. It was basic information that elements with a high atomic weight would cast a better radiologic shadow than would elements with a low atomic weight. Knowing this, we thought it desirable to try strontium and calcium salts of the halogenated phenolphthaleins rather than sodium. Most of the free acid phenolphthalein compounds are insoluble in water, requiring a weak alkali solution (e.g., sodium hydroxide) to dissolve them.

For several months, one after another, we tried the sodium, calcium and strontium salts of tetrabromphenolphthalein and tetraiodophenolphthalein, confining the injections to dogs and rabbits. The first sample of tetraiodophenolphthalein was more toxic to our dogs than was tetrabromphenolphthalein. Therefore, for a time we concentrated on the latter drug.

I must have injected as many as 200 dogs and rabbits without obtaining a single gallbladder shadow. We knew that it would require six to ten hours after injection of the solution for the gallbladder to concentrate it to a maximal degree. Therefore, if we started our injections at 8:30 A.M. or 9:00 A.M. it would be undesirable to take roentgenograms much before 5:00 P.M. We had no x-ray equipment in our laboratory so we had to transport the animals across the street (via a tunnel) to the x-ray room at the hospital; this transportation fell to my lot since our laboratory assistants stopped work at 5:00 P.M. sharp, although they would kill the dogs (with ether) before they left. I shall always be grateful to our hospital x-ray technician, Miss O'Brien, who stayed overtime so often and made sure that we had good films before she left for the day. Without her complete and

* Actually tetraiodophenolphthalein was an old compound, having been used previously as a dusting (antiseptic) powder.

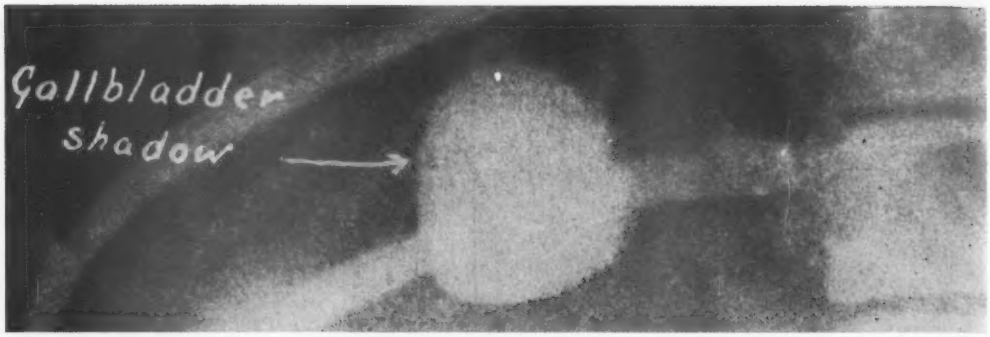


FIG. 2. The first successful cholecystogram in a dog. The animal, weighing 5.25 kg., was given 1.5 gm. of tetrabromphenolphthalein with 0.3 gm. of calcium hydroxide. (FROM: GRAHAM, E. and COLE, W. Roentgenologic examination of the gallbladder. *J. A. M. A.*, 82: 613, 1924.)

congenial cooperation the experiment would have been more difficult and discouraging.

SUCCESS AND THE ROLE OF SERENDIPITY

After four and a half months of negative results we finally obtained a gallbladder shadow (Fig. 2) in one of our dogs; it was a dense shadow and assured me that the procedure could surely be duplicated, at least in animals. As soon as I saw the film I called Dr. Graham, who was working late as usual. We stood there admiring the dripping film with a white blob in the center, as if we had found a treasure chest full of gold. After a few moments of silence he slapped me on the back and announced enthusiastically, "Well, Warren, we have a muskie on the line, and if the line doesn't break or the boat capsize we should land him."

I do not have the exact date of this first successful injection, but I believe it was between November 15 and November 29, 1923. My log book for animals disappeared, as did the x-ray film of the dog showing the dense shadow. The latter occurred the same time we had a visitor in town. After returning from a meeting two or three years later Dr. Graham told me he had been told by a friend of his that a certain individual had the first successful cholecystogram in his possession. Dr. Graham was very reluctant to talk about the missing films, but somehow he was instrumental in recovering them. Moreover, following a recent inquiry, Glover Copher tells me the first successful animal and human cholecystograms are now in the cholecystography exhibit in the Mallinckrodt Institute of Radiology.

As might be expected, I injected two or three dogs on each of the next few succeeding days but not a single shadow was obtained. I went back over the method of making up the solution (calcium tetrabromphenolphthalein) and injecting it, but could find no lead as to why we should obtain an excellent shadow of the gallbladder in one animal but none in any of the others. Finally, in desperation, I looked up Bill (the animal caretaker) and asked him if he had done anything to that particular dog which he had not done to the others. Was anything abnormal about him? Bill hesitated, stammered a bit, and finally announced that he could think of no way in which that animal differed from the others. However, his expression of apprehension melted considerably when he learned that that dog was a favored one and very meekly, as if fearing a sharp reprimand from me, muttered, "Well, Dr. Cole, there was one thing somewhat different. I forgot to feed that dog the morning you injected him." I lunged at him, apparently like a wild animal, trying to slap him on the back and grasp his hand in appreciation at the same time. He retreated hastily, no doubt, thinking I was going to manhandle him. However, I quickly convinced him I was merely trying to express my appreciation for the great favor he had unknowingly conferred upon me. The lack of food during the test with this dog represented a definite difference from the routine carried out with the other dogs, and I was willing to assume it might be a vital point. Besides, a short time previously Boyden [4] had reported at the Annual Meeting of the American Society of Zoologists that feeding, especially fat, was an important item in the filling and emptying of the gallbladder (in the

eat), although he had not yet worked out the exact role feeding played in the physiology of the gallbladder. Nevertheless, I felt confident we had now discovered a change in routine which would duplicate the excellent shadow encountered in the animal accidentally having the test made during a starvation period. Subsequent experiments during the next few days proved that the role of food in the prevention of filling of the gallbladder was an all-powerful one.

Having found a method of visualizing the gallbladder in animals, we moved rapidly to develop a technic which could be utilized in the human being.

PHARMACOLOGY OF THE PHENOLPHTHALEINS, AND APPLICATION OF THE METHOD TO HUMAN BEINGS

Tetrabromphenolphthalein (Fig. 1) has a molecular weight of 634, and by weight contains about 50.4 per cent bromine. Tetraiodophenolphthalein has a molecular weight of 822 and contains about 61 per cent iodine. We were aware of the apparent superiority of the iodine compound over the bromine one, but our animal experiments indicated an inconstant toxicity with the iodine compound, which we learned later was due to impurities. The lethal dose of the various halogenated phthaleins is about the same, namely, 0.2 to 0.3 gm. per kilogram of body weight which is about one-fifth the dose required for clinical use with the iodine compound, but about one-third the clinical dose for the bromine compound; with this dose the dogs would usually die in eight to ten hours. When we gave these drugs to animals our dose was only slightly below the lethal level, but when we began their use in human beings we deliberately cut the dose to one-third the lethal amount for the bromine compound, and about one-fifth the lethal dose for the iodine compound, because we wanted a margin of safety fully that large when adopting the method in the human being.

We soon became aware that the toxicity was related to the phenolphthalein radical and not to the halogen or positive ion used to make the soluble salt. In the animal we found that a rapid intravenous injection of the media would produce a fall in blood pressure. In sublethal doses hepatic necrosis is commonly found after intravenous injection, but not following the amount used for the human being. Hematuria was noted occasionally. With sublethal doses, utilizing either the oral or intravenous route, animals would frequently vomit. Diarrhea was common after oral administration but not after intravenous injection. A dose of 0.35 gm. per kilogram of body weight to dogs was usually fatal instantly.

PREPARATION AND ADMINISTRATION OF THE MEDIA FOR CLINICAL USE

As stated previously, an alkali had to be used to dissolve the insoluble halogenated phenolphthalein. For this purpose we used either sodium hydroxide, calcium hydroxide or strontium hydroxide. At first I concentrated on the latter two because calcium and strontium have a higher atomic weight than sodium. We appreciated later that the amount of these elements in the solution was so small, compared to the halogen, that sodium was as good as strontium; moreover, it was more physiologic. By a process of trial and error I learned that for each gram of tetrabromphenolphthalein, 0.2 gm. calcium hydroxide had to be added to 50 or 60 cc. of distilled water to dissolve the compound; even then the mixture had to be ground with a mortar and pestle. Twice as much strontium hydroxide was required.

The Intravenous Use of Calcium Tetrabromphenolphthalein. Since calcium tetrabromphenolphthalein was used in the dog in which we obtained the first visualization of the gallbladder, we naturally chose this particular solution for clinical use.

I began the clinical use of the solution (calcium tetrabromphenolphthalein) very cautiously, giving 1 gm. of tetrabromphenolphthalein to the first patient (Fig. 3) and gradually increasing the dose up to 5 or 5.5 gm. I increased the dose for the next four patients by 1 gm. each, giving 5 gm. to the fifth patient. This patient experienced the first reaction I encountered, nothing more than a short feeling of warmth over the entire body. I gave 6 gm. to the sixth patient, again with no more reaction than a slight feeling of warmth. However, at this point I had used up my share of good luck; in the seventh patient tachycardia, headache, vertigo and nausea developed, as it did in many thereafter. With the small doses used in the first few patients we did not expect to obtain visualization of the gallbladder; we were merely testing the drug for toxicity. I had given the material to nine patients before obtaining

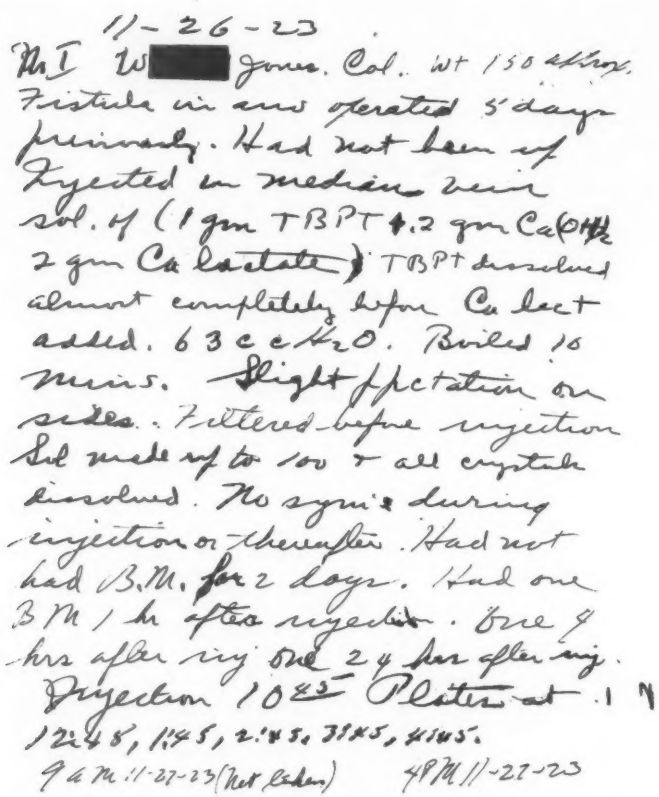

11-26-23
Mr I W[redacted] Jones. Col.. Wt 150 abt Age.
Fistula in ano operated 5 days
previously. Had not been inj
Injected in median vein
sol. of (1 gm TBPT 4.2 gm CaOH2
2 gm Ca lactate) TBPT dissolved
almost completely before Ca lact
added. 63 c c H2O. Boiled 10
mins. Slight ppt'tation on
sides. Filtered before injection
Sol made up to 100 + all crystals
dissolved. No symts during
injection or thereafter. Had not
had B.M. for 2 days. Had one
B M 1 hr after injection. One 4
hrs after inj One 24 hrs after inj.
Injection 10[23] Plates at .1 .4
12:48, 1:45, 2:45, 3:45, 4:45.
9 a M 11-27-23 (Not Taken) 4 P M 11-27-23

FIG. 3. Photograph of page 1 of my log book. We were using proper caution, as indicated by the fact that I gave this patient, the first one, only 1 gm. of tetrabromphenolphthalein. No reaction was sustained by the patient.

the slightest evidence of a shadow. The last two received a full dose (5.5 gm.) of the solution, but had typical symptoms of gallbladder disease; no doubt the use of our modern drugs for visualizing the gallbladder in those patients would also have yielded "no shadow."

From some previous analyses of gallbladder bile for iodine, which I had done following the injection of sodium tetraiodophenolphthalein, I knew that iodine began to appear in the gallbladder three or four hours after injection and was present in fairly high concentrations (enough to produce an x-ray shadow by the eighth hour). For this reason we adopted four, eight and twenty-four hours after injection of the media as the time x-ray films should be taken. This preliminary guess turned out to be accurate; as long as we continued the intravenous method we utilized this time interval.

For several reasons I shall never forget the first patient in whom a positive visualization was obtained. She was the sixteenth patient injected, a nurse at Barnes Hospital.

I mixed the solution (6 gm. of tetrabromphenolphthalein in 350 cc. of water with 1.1 gm. of calcium hydroxide and 2 gm. of calcium lactate) at 7:00 A.M. as usual, allowing for time to sterilize and cool it before beginning the injection at 9:00 A.M. This was on February 21, 1923. I had already learned that rapid injection of this solution tended to increase the reaction. Accordingly, I gave the injection very slowly, hoping to avoid a reaction completely. However, my hopes were blasted. Reference to my log book kept for patients indicated that after injection of slightly over half of the solution the patient began complaining of nausea (Fig. 4), followed shortly by pain in the back and else-

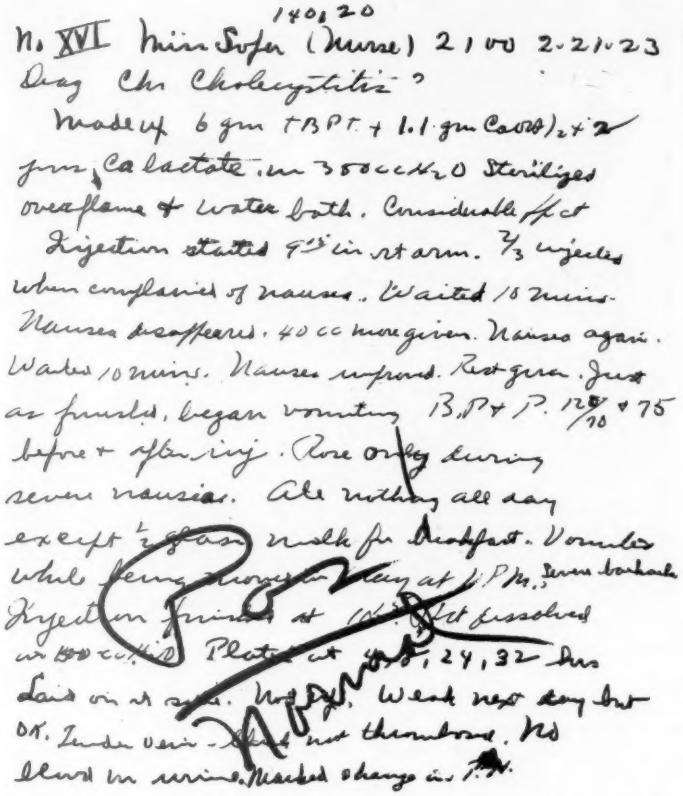

No. XVI
Miss Sofer (Nurse) 2100 2-21-23
Diag Chr Cholecystitis?
Made up 6 gm TBPT + 1.1 gm Ca(OH)2 + 2
gm Ca lactate in 350 cc H2O Sterilized
over flame & water bath. Considerable ppt
Injection started 9:15 in rt arm. 2/3 injected
when complained of nausea. Waited 10 mins.
Nausea disappeared. 40 cc more given. Nausea again.
Waited 10 mins. Nausea unpmd. Rest given. Just
as finished, began vomiting B.P. + P. 120/70 + 75
before + after inj. Rose only during
severe nausea. Ate nothing all day
except ½ glass milk for breakfast. Vomited
while being X-rayed at 4 P.M. Severe backache
Injection finished at 4:30 Ppt dissolved
in 350 cc H2O. Plates at 4:45, 24, 32 hrs
Laid on rt side. No pain. Weak next day but
OK. Under observ - Chest not thumbed. No
blood in urine. Marked change in P.N.

FIG. 4. Photograph of my notes on the first patient upon whom a definite cholecystographic shadow was obtained (see Figure 5). She experienced severe nausea, back pain and mild vomiting, and was extremely miserable. She was a nurse, and therefore I felt particularly apprehensive about her welfare. However, after about twenty-four hours her symptoms disappeared although she told me she had no appetite for days.

where. I stopped the injection and waited ten minutes; the nausea disappeared so I renewed the injection. After receiving 40 cc. more the nausea returned, so I stopped the injection again for a few minutes. After repeating this process of stopping and starting the injection several times, I was finally able to complete injection of the entire amount, although it required over an hour for completion. I had been watching her pulse and blood pressure closely and since they had remained practically normal, I had the courage to proceed with the injection until I had injected all of the solution. It is fortunate that we obtained a good visualization (Fig. 5) of the gallbladder; otherwise, after seeing the patient in such misery with severe nausea, retching and generalized pain, I doubt that I would have had the courage or "cruelty" to continue with injection of other patients. Her clinical symptoms, as I recall them, consisted primarily of pain in the right upper quadrant radiating posteriorly. Although she had no significant urinary symptoms, it is my recollection that the cause of the pain was later identified as renal in origin. We knew enough about the physiology of the gallbladder to recognize that good visualization could be achieved only by a normal gallbladder. Ac-

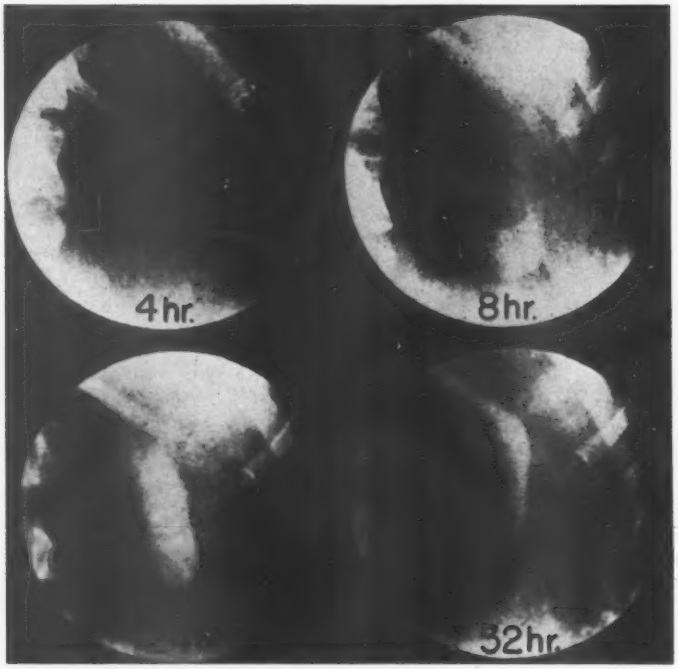


FIG. 5. The first successful cholecystogram in the human being obtained February 21, 1923. The patient received 5.5 gm. of tetrabromphenolphthalein. Films were taken at four, eight, twenty-four and thirty-two hours. No shadow is seen on the four-hour film; on the eight-hour film the shadow is large and faint. The dense shadow is observed at twenty-four hours. The persistence of the shadow is attributed to the prolonged starvation period. (FROM: GRAHAM, E., COLE, W., COPHER, G. and MOORE, S. Diseases of the Gallbladder and Bile Ducts. Philadelphia, 1928. Lea & Febiger.)

cordingly, we eliminated gallbladder disease as a possible diagnosis, and no doubt saved the patient a needless cholecystectomy.

The dense normal gallbladder shadow obtained in this first positive test gave us renewed enthusiasm, and we were now convinced that our theory of roentgen diagnosis was valid. However, we had no idea how often the media would get into the gallbladder containing stones, and just what the contrast of the stones and opaque media would look like.

The necessity of performing the test without breakfast, a lesson we had learned the hard way after months of negative findings in animals, was not forgotten. It appeared so important that I planned a series of experiments on dogs trying out the effect of various foods and chemicals on the sphincter of Oddi. After much experimentation I learned that the sphincteric action of the sphincter of Oddi could be controlled by acid and alkali [5]. By cannulating the common duct and connecting the tube to a manometer system, I learned that substituting 75 to 150 cc. of 0.5 per cent sodium hydroxide for saline in the stomach caused the pressure to rise 100 to 225 mm. Hg. Replacement of the sodium hydroxide with 75 to 150 cc. of 0.5 per cent hydrochloric acid caused an immediate drop in pressure of 75 to 150 mm. Hg, indicating that the acid caused a relaxation of the sphincter and alkali caused a contraction. As a consequence of this experiment we advised and continued the use of 2.5 gm. of sodium bicarbonate every three hours while the patient was awake, during the first twenty-four to forty-eight hours following injection of the media.

After a certain amount of trial and error, mixed with what little physiology of the gallbladder was known at that time, we devised a

set of rules or regulations to be used for patients during cholecystography, to increase the density of the shadow. Quoting from our first report [6] on visualization of the gallbladder, the technic of preparation and injection of the solution for use in patients was as follows:

"Six grams of tetrabromphenolphthalein is mixed with 1.2 grams of calcium hydroxide, ground in a mortar with a few cubic centimeters of water, and dissolved in from 325 to 350 cc. of distilled water. Addition of calcium lactate was found to produce a more stable solution and slightly increase its solubility. Therefore, a solution of 2 gm. of calcium lactate in a few cubic centimeters of water is added. The solution has been sterilized by heating it to the boiling point over a flame, and maintaining the temperature between 95 and 100°C. for fifteen minutes. Occasionally, a small amount of the calcium salt precipitates on the bottom of the receptacle. This dissolves readily on the addition of a small amount of water or saline solution, after the clear solution is decanted off. The solution is filtered and given intravenously by the gravity method, similar to an arsphenamine injection. The solution is introduced slowly. Usually from twenty-five to thirty minutes is consumed in the injection, so that symptoms, if present, can be detected early. Roentgenograms of the gallbladder region are taken at intervals of several hours, beginning three hours after the injection."

Orders for the patients, as listed in our second report [7], were as follows:

1. Omit breakfast.
2. Omit lunch (a glass of milk may be given if hunger is too pressing).
3. Take 40 gr. (2.6 gm.) of sodium bicarbonate every three hours for forty-eight hours day and night while awake.
4. Lie on the right side of the abdomen or be up.
5. Take water, if desired, by mouth.
6. Omit protein from the evening meal on the day of injection.
7. Take x-ray films at four-, eight-, twenty-four– and thirty-two–hour periods (no special technic).

The Intravenous Use of Sodium Tetrabromphenolphthalein. The severe reaction sustained by the first patient in whom we obtained a dense shadow convinced me that we should try the sodium salt. We were suspicious that the distilled water contained toxic products, although work on pyrogens was only in its infancy at that time. In fact, in our second publication [7] we stated, "It seems quite probable that the large amount of fluid (i.e., distilled water) used in the injection of the calcium solution was responsible for part of the reaction." Accordingly, we changed immediately to the sodium salt [7] and shortly after had the Mallinckrodt Chemical Works prepare the sodium salt. This they were very willing to do because it was obvious that the material truly had commerical value. This put me out of the pharmaceutical manufacturing business, a very welcome change, because the injections themselves, although less time-consuming due to the use of the more soluble sodium salt, were still taking up too much of the time I wanted to preserve for research on better chemicals and a wider application of the process (i.e., visualization of the kidney, spinal canal and cerebral ventricles). We elected to give the sodium tetrabrom solution in two injections of 20 cc. each, one-half hour apart, and found that this truly reduced the reaction considerably. We maintained this principle of giving the media in two doses even after we adopted the use of sodium tetraiodophenolphthalein and sodium phenoltetraiodophthalein, as will be described later. For these injections I devised a carrier (Fig. 6) for the use of two 20 cc. syringes, one containing saline and the other the media. This simplified the injections and minimized the danger of extravasation of the solution which would produce a slough if more than 1 or 2 cc. escaped outside the vein.

The Intravenous Use of Sodium Tetraiodophenolphthalein. Shortly after we adopted the use of sodium tetrabromphenolphthalein we began trying sodium tetraiodophenolphthalein, because the higher atomic weight of the iodine (127 versus 80 for bromine) would allow us to give a smaller dose [8]—3.5 gm. for an adult. Unknown to us, Whitaker and Milliken [9] were also working on a comparison of sodium tetrabromphenolphthalein and sodium tetraiodophenolphthalein, pointing out the advantages of the latter. Both of these articles appeared in print in January 1925.

Oral Administration of Sodium Tetraiodophenolphthalein. The next step was to try oral administration, comparing its accuracy with intravenous administration. We reported our comparative experiences in September 1925 [10] noting that shadows could be obtained with the

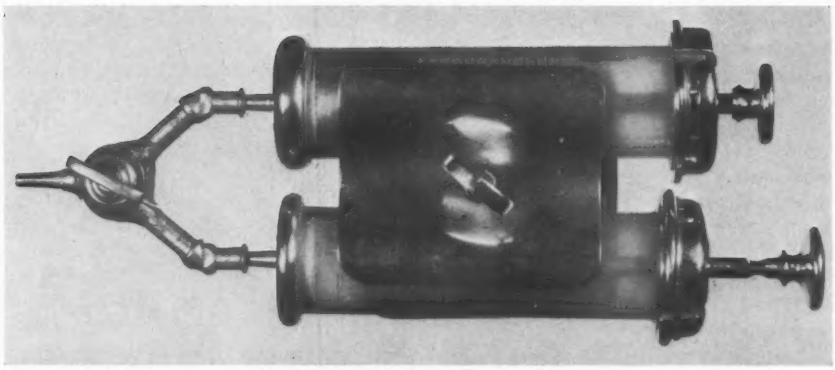


FIG. 6. Carrier for two syringes which I devised and had made to allow alternate injections of physiologic saline solution and dye. This allowed us to stop the injection temporarily (and keep the needle open with saline) if a reaction was sustained. Often, early mild symptoms would disappear in a few minutes if the injections were stopped or the rate decreased.

oral method but that accuracy was greater following the intravenous method. Using the oral route, the time interval for taking films would obviously be different, e.g., fourteen, eighteen and twenty-four hours after administration of the capsules containing the media. However, a short time later Menees and Robinson [*11*] reported fairly accurate interpretation of gallbladder shadows following the use of sodium tetraiodophenolphthalein in a dose of 3.5 gm. in adults. Soon after, most clinicians adopted the oral route because it was so much more convenient than the intravenous one. Moreover, it avoided most of the serious reactions produced by intravenous administration. However, nausea, vomiting and diarrhea were still fairly common with the oral method, and if a sufficient amount of media were lost, a repetition of the test was necessary. We recognized this early in our work and found that coating the capsules with keratin slowed up the exposure of the gastric and intestinal mucosa sufficiently to lessen the reaction.

Simultaneous Cholecystography and Liver Function. In our research for better media, we turned our attention to the phenoltetrahalogenphthalein compounds, which are isomers of the tetrahalogenophenolphthalein compounds. Tetradiodophenolphthalein is a blue powder which, when dissolved in water containing a weak alkali, produces a blue solution that does not stain the blood serum. Sodium phenoltetraiodophthalein is a purple powder producing a beautiful fluorescent purple color in solution which stains the blood serum, particularly when a drop of weak alkali is added to a tube of the patient's serum. Our knowledge of the staining qualities of the phenoltetraiodophthalein compounds led us to adopt the use of this drug as a simultaneous test for hepatic and gallbladder function [*12*]. Much to our gratification, we found that only 2.5 gm. of sodium phenoltetraiodophthalein was necessary to produce good shadows of a normal gallbladder. We thought that the use of 40 mg. per kilogram of body weight would improve the validity of the liver function test, since the dose of dye in other tests used at that time was much smaller, perhaps so small that a minor liver impairment might not be detected. A control specimen of 7 or 8 cc. of blood was drawn from the patient, and another sample was obtained thirty minutes and sixty minutes after injection of the dye. Serum was separated from the blood by centrifugation, and a small drop of 10 per cent sodium hydroxide was added to the thirty- and sixty-minute samples. By using a comparator box popularized by Rosenthal, we could determine the amount of dye remaining in the serum. We found that a retention of 10 to 12 per cent in thirty minutes and 5 per cent or less in sixty minutes was normal. This test was surprisingly accurate in detecting hepatic disease, and was very helpful in determining operability. For example, we found [*13*] that the mortality rate after operation in patients with a high retention was definitely higher than in patients with a normal retention. Because of this fact and the added low dosage required (with minimal reaction), we continued to use

this compound intravenously for several years after other clinicians adopted the oral use of sodium tetraiodophenolphthalein.

REACTIONS

The incidence of reactions following the use of the halogenated phenolphthalein compounds for cholecystography was extremely high, especially after the intravenous administration of calcium tetrabromphenolphthalein which was so insoluble it had to be dissolved in 300 to 350 cc. of distilled water. As mentioned previously, knowledge of pyrogens was in its infancy at that time, but we suspected (and probably correctly so) that part of the reactions following injection of this solution was due to the fluid (i.e., the distilled water) used in the preparation of the solution. We found out early that the drug reactions were due to the phenolphthalein radical, and were not related to the bromine or iodine or base used to dissolve the acid powder. The amazing feature about these reactions, which is still difficult to understand, is that in spite of their severity and frequency, fatalities were practically non-existent. Of the 2,000 or 3,000 patients to whom we gave the drugs orally or intravenously, there was only one death, and it could not be classified as a direct fatality resulting from cholecystography. The patient, a woman about sixty-eight years old, had a fairly severe reaction consisting of nausea, vomiting, vertigo and chill, and died of a vascular collapse during the night about twenty hours later. We did not obtain an autopsy on this patient but since the vascular collapse occurred fifteen hours after the injection (sodium tetrabromphenolphthalein), it seems likely that she had a coronary occlusion or perhaps a pulmonary embolus. In our book "Diseases of the Gallbladder and Bile Ducts" [*13*], written four years after the introduction of cholecystography, we remark that "of the thousands of patients known to have undergone the test of cholecystography, this (meaning a case reported by Huddy) is the only authentic record of a fatality which has come to our attention." This death followed the intravenous administration of 5.5 gm. of tetraiodophenolphthalein, a much larger intravenous dose of that drug than we had used.

The frequency and severity of these reactions were so pronounced that each injection was a tremendous ordeal to me, not only because of the great discomfort the patients complained of but also because I never knew when the injection might result in a fatality. If apprehension is truly an important factor in the production of peptic ulcer or coronary thrombosis, surely I would have acquired one or the other but I did not.

In Table 1 are listed the reactions summarized in our book [*13*].

We defined first degree reactions as those consisting of vertigo, headache, backache, slight nausea, weakness or urticaria. Second degree reactions consisted of severe nausea, vomiting, chill, circulatory depression, fever or severe abdominal cramps. If more than one symptom in the first degree reactions was encountered, the reaction was classified as second degree.

Fortunately the patients recovered rapidly from their reactions; usually all symptoms had disappeared within four or five hours after termination of the injection. As noted in Table 1, the incidence of reactions was greater following the oral method than after the intravenous method. However, without question, the reactions were less severe and less dangerous after oral administration. Although diarrhea is an undesirable reaction, it is not as alarming as a vascular collapse with a drop in blood pressure, which occured in 5 to 8 per cent of the patients having intravenous injection. To my best recollection, only in three or four patients did the blood pressure drop to a point where it was unobtainable.

Case [*14*], a radiologist, adopted the use of cholecystography very soon after we reported it. In summarizing his experience he stated that of more than 1,600 patients receiving injections for cholecystography, only one gave him serious concern from the standpoint of reaction. Perhaps he was not as apprehensive as I. We learned a very comforting fact from Dr. Case, namely, that Adrenalin® (intramuscularly or in small doses intravenously) will quickly bring the blood pressure back to normal, if it shows a decline during injection of the media. Actually, for a time we administered a few minims intramuscularly just before the injection to prevent a vascular depression.

As time progressed the incidence of reactions following the oral and intravenous methods of administration diminished in frequency and severity. Part of this improvement was probably due to a betterment in the manufacture of the material, obtaining a purer product

TABLE 1*
REACTIONS TO VARIOUS CONTRAST MEDIA

Reaction	No. of Cases	Per cent
Tetraiodophenolphthalein (300 Cases)		
Intravenous method:		
No reaction	96	46.9
First degree reaction	75	36.6
Second degree reaction	34	16.5
Total	205	....
Oral method:		
No reaction	31	33.3
First degree reaction	17	18.3
Second degree reaction	45	48.7
Total	93	....
Rectal method (No reaction except difficulty in retaining the solution)	2	....
Phenoltetraiodophthalein (First 487 Cases)		
Intravenous method:		
No reaction	297	61.5
First degree reaction	130	27.3
Second degree reaction	54	11.2
Total	481	....
Oral method:		
No reaction	3	50.0
First degree reaction	2	33.3
Second degree reaction	1	16.6
Total	6	....
Phenoltetraiodophthalein (200 Subsequent Cases)		
Intravenous method:		
No reaction	136	68.0
First degree reaction	51	25.5
Second degree reaction	13	6.5
Total	200	....

* Modified from: GRAHAM, E., COLE, W., COPHER, G. and MOORE, S. Diseases of the Gallbladder and Bile Ducts. Philadelphia, 1928. Lea & Febiger.

It was also true that our use of phenoltetraiodophthalein was followed by fewer reactions, even though we gave this media all at one time, consuming at least five minutes for the injection. Utilizing the double syringe apparatus (Fig. 6) allowed us to administer the solution (20 cc.) slowly without danger of clotting in the needle or vein, because by turning a stopcock we could inject physiologic saline solution for a short time.

We had very few contraindications to cholecystography. The only real one was cardiac disease. For a time we gave the agents to jaundiced patients without undue reactions; however, after obtaining no visualization in twenty or twenty-five patients with jaundice we abandoned it in such cases. We listed "threatened uremia" as a contraindication [*13*] but I do not know why. I suppose that condition might be listed as a contraindication to the use of any of the modern drugs used for cholecystography.

ROENTGENOLOGIC INTERPRETATION

When we obtained the first cholecystographic shadow we realized there would be many problems in interpretation of the shadows, especially when a few small stones were present in the gallbladder. This difficulty was emphasized by a few experiments I performed on dogs, placing human gallstones in the dog's gallbladder containing bile and a weak solution of sodium tetrabromphenolphthalein.

Realizing the difficulty which would be present in interpretation of the shadows, very early in our work we asked Dr. Sherwood Moore, Head of the Department of Radiology at Washington University School of Medicine and Barnes Hospital, to join us in the continued investigation.

By taking frequent x-ray films we soon learned that following the intravenous administration of the media to a patient with a normal gallbladder, a shadow should begin to appear at four hours, reach a maximum density in twelve hours and either sharply diminish in size or completely disappear by twenty-four hours. Following oral cholecystography we quickly learned that visualization of a normal gallbladder began in nine or ten hours, reaching a maximum in eighteen or twenty hours.

The mechanism of emptying of the gallbladder was obviously of great importance in the interpretation of the variations in the density of the shadow. It was known that the normal gallbladder wall could absorb large quantities of water [*3*], but it was questionable whether it could absorb the halogenated phenolphthaleins. Copher [*15*], who began working with Dr. Graham and myself at about the same

FIG. 7. The deformed shadow in this cholecystogram suggests a deformity due to adhesions, but at operation for interval appendicitis the gallbladder was found free and pendulous. The condition resembling folding due to adhesions was no doubt due to folding of the gallbladder produced by the prone position of the patient while the film was being taken. (FROM: GRAHAM, E., COLE, W., COPHER, G. and MOORE, S. Diseases of the Gallbladder and Bile Ducts. Philadelphia, 1928. Lea & Febiger.)

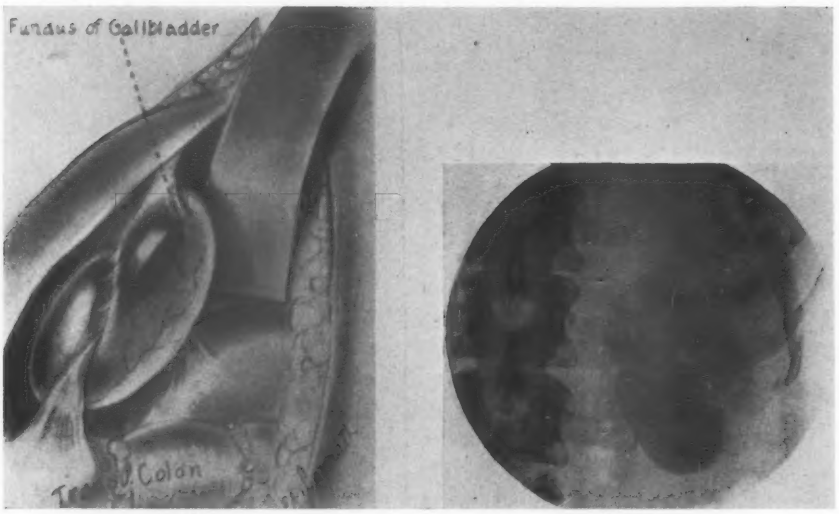
time Sherwood Moore did, conducted an experiment to see if this were true. He produced dense shadows of the gallbladder with sodium tetraiodophenolphthalein and then ligated the common duct. The shadows persisted for days with very little change, indicating that the opaque media left the gallbladder as it entered by way of the cystic and common ducts and not by absorption into the lymphatics or blood vessels.

The change in the size of the shadow was difficult to explain, but ultilizing the knowledge that a fat meal empties the gallbladder [*4*] it appeared that this contraction of the shadow was related to the ingestion of food. Sosman, Whitaker and Edson [*16*] popularized the use of the fat meal in determining the emptying power of the gallbladder, but this variation in technic has long since been abandoned.

Early in our experience we learned that the lack of a shadow after cholecystography was attributed to a diseased gallbladder; in fact, even before we obtained the first gallbladder shadow we suspected a diseased gallbladder would cast no shadow. Much more difficult to interpret was a faint shadow. We correctly attributed this to impaired gallbladder function realizing that the density would be jeopardized by poor technic, and in fat people.

The filling defects of stones were, of course, self-explanatory, and were expected before we saw them. Neither were we surprised to find negative shadows and positive shadows, because the difference between cholesterol and calcium stones was already known.

Perhaps the biggest error we made in our roentgenologic diagnosis was in the interpretation of deformed shadows. I never shall forget our deep chagrin when we found a normal gallbladder in a young woman with a badly deformed gallbladder shadow. (Fig. 7.) We thought for sure that this deformity was



8A 8B

FIG. 8. A, artist's drawing at operating table of adhesions producing sharp angulation of gallbladder. B, the cholecystogram in this patient revealed a shadow of normal denisty but a deformity consistent with the anatomic deformity found at the operating table, thus indicating that adhesions can produce deformed cholecystographic shadows. (FROM: GRAHAM, E., COLE, W., COPHER, G. and MOORE, S. Diseases of the Gallbladder and Bile Ducts. Philadelphia, 1928. Lea & Febiger.)

caused by adhesions. However, we soon learned that most of these deformities were produced by pressure against the gallbladder, with the patient lying on the table at the time the x-ray films were taken. However, now and then we would be rewarded by finding a dense adhesion causing a deformed shadow. (Fig. 8.)

Needless to say, Dr. Moore was of great help to us; in the early days of cholecystography (as well as now) we often encountered cases in which doubtful negative or positive shadows were superimposed on the shadow produced by the cholecystographic media. We were delighted to transfer the responsibility of these diagnostic problems to him. More than that, he was a source of inspiration, offering encouragement during my discouraging moments and extending to me a hospitable welcome into his x-ray department.

We presented "cholecystography" at various medical meetings, but relied on Dr. Moore to take care of the presentations at the radiological meetings. For some strange reason, cholecystography was received early with much less enthusiasm by our friends in radiology than any other group. About that time the technic of diagnosing gallbladder disease by variations in the density of the shadow of the diseased gallbladder and by examining the bile obtained by tube from the duodenum was being developed; I do not blame the radiologic profession for being reluctant to have a third method of diagnosing gallbladder disease introduced to add to the confusion and controversy. Just a short time ago, Dr. Moore [*17*] related to me some of the cool receptions received at radiology meetings. At one meeting a member of the society arose in discussion to denounce cholecystography as being worthless, and added that anyone giving the media by vein "should be put in jail." At another meeting a paper entitled "Gall and Gallbladder Diagnosis" denounced cholecystography as being worthless. Dr. Moore stated this was the most venomous attack he had ever heard delivered against any method or procedure.

I am not relating these two incidents to indicate that the radiologists were "picking" on us, because at about the time these incidents occurred (1926) the American Roentgen Ray Society awarded us the Leonard Research Prize for the development of cholecystography. A year later the St. Louis Medical Society gave us a certificate of merit in recognition for our introduction of cholecystography.

Among numerous favors Dr. Moore extended

me, I appreciated one particularly. He made arrangements to have Dr. Louis Aitken give the injections of cholecystographic media within a year or two after we began the use of sodium tetraiodophenolphthalein intravenously. Recently Dr. Aitken [*18*] related some of his experiences with reactions to me, saying that minor reactions consisting of flushing of the skin, a feeling of warmth and urticaria were fairly common, but serious reactions of vascular collapse were quite uncommon. Dr. Aitken recalls a very strange reaction in a patient, which for a time had us totally confused. This patient was quite apprehensive, and hyperventilation, carpopedal spasm and fixation of the jaw developed. At first we were at a complete loss to explain this reaction of the tetany type and were about to add another type of reaction to the long list already observed; however, the mystery was cleared rapidly when Dr. Aitken discovered that the patient had been taking a large amount of alkali (as citrocarbonate) to counteract his ulcer symptoms. Dr. Aitken stated he had a lot of difficulty with "spasm" of the veins during injection, due presumably to the severe irritating effect of the concentrated solution. To prevent this he changed the technic by injecting the solution through rubber tubing after intravenous saline solution was started. This minimized the danger of extravasation which would be serious if allowed to go unnoticed; however, extravasation resulted in so much pain immediately after its development that there was very little probability much of the solution could escape into the tissues unnoticed.

REVIEW OF 1923 LOGBOOK

With the hope of obtaining accurate data and not having to rely on memory, I contacted Hugh Wilson, Professor of Radiology at Washington University in St. Louis, asking him if he could send me one or two of our logbooks for my perusal. Several years ago Dr. Wendell Scott, now Professor of Radiology at Washington University, assembled for an exhibit all the notebooks he could find, along with syringes and bottles with various colored dyes utilized in the development of cholecystography.

I was amazed how readily I could read the description of these injections and the reactions sustained by the patients. In the thirty-six years between the time I had recorded these observations and the present, the ink had not faded and the writing was surprisingly legible.

One of these logbooks included our early experience with patients. It indicates that we injected our first patient with sodium tetrabromophenolphthalein on November 26, 1923. (Fig. 3.) I was extremely cautious and gave patient W. J. only 1 gm. of the dye. Actually the median lethal dose in animals is about twenty-five times this amount, but we had learned from published data on phenolphthaleins and our contact with tetraiodophenolphthalein as well as tetrabromophenolphthalein that the toxicity in animals appeared to be variable. We expected that some patients might be much more sensitive to these phenolphthalein compounds than others, although we had no evidence that a serious sensitization of the anaphylactic type could be induced by two or more injections. I dissolved 1 gm. of tetrabromophenolphthalein in 4.2 gm. of calcium hydroxide and 2 gm. of calcium lactate. Having sustained no reaction with the first injection in patient W. J. we decided to repeat the injection with double the dose two or three days later. No reaction was sustained with this dose either.

Our next patient was given 3 gm., the third patient 4 gm., and the fourth 5 gm. The cholecystogram of the fifth patient who received 5 gm., revealed a very slight shadow but it was too faint to be of definite diagnostic aid. We were encouraged by these films, but knew we would have to do better if the test was to become practical.

The first shadow (Fig. 5) we obtained was in the sixteenth patient injected, a nurse. In another sense she also represented a milestone; she sustained such a severe reaction that I determined we must change to the sodium salt (which is much more soluble) and thus eliminate the necessity of giving such a large quantity of water which we thought might be responsible for some of the reactions. The higher percentage of contamination of distilled water with pyrogens, as demonstrated shortly after this period, makes me wonder how we got along without more serious reactions and even a few deaths. For the injection in this sixteenth patient, I made up a solution of 6 gm. of tetrabromphenolphthalein, 1.1 gm. of calcium hydroxide plus 2 gm. of calcium lactate in 350 cc. of distilled water. (Fig. 4.) I had already injected several patients with 6 gm. of the dye without any dangerous reactions, although

almost all of these patients had mild toxic symptoms of one type or another.

Capitalizing on the accidental discovery that omission of a meal preceding injection of the dye was essential to a shadow, we omitted breakfast in all of these patients and gave them only a glass of milk for lunch. For reasons given elsewhere herein, we also gave 40 gr. of sodium bicarbonate every two hours for forty-eight hours (while the patient was awake). We allowed the patients to be up, but while lying down they were instructed to lie on their right side. We must have assumed that gravity would aid in the distribution of dye into the gallbladder of the patient lying on his right side, but I know of no data to substantiate this theory. I suppose we would have to identify this supposition as some type of superstition, but I do not know of any data disproving the idea either. Who knows but what this position might have accentuated the shadows.

I found from my notes that I administered the first dose of sodium tetrabromphenolphthalein to our thirty-eighth patient on March 20, 1924. I do not know why we delayed so long after the first positive cholecystogram before adopting the sodium salt, but I believe it was because our animal experiments with the sodium salt did not reveal shadows as dense as those obtained with the calcium salt. About this time we found that 5 gm. of tetrabromphenolphthalein would produce shadows about as dense as those produced by using 6 gm., and after this date gave no more than 5 gm.; moreover, the incidence of reactions was greater with the larger dose. To this thirty-eighth patient I gave 5 gm. of tetrabromphenolphthalein mixed with 0.85 gm. of sodium hydroxide to obtain a solution. This sodium salt was very soluble but the 5 gm. dose was diluted up to 30 or 35 cc. To minimize reactions I gave the 35 cc. in two divided doses one-half hour apart; this reduced the reactions markedly. To assist in the injection of this concentrated solution I devised a two-syringe apparatus (Fig. 6) which would allow injection of a few cubic centimeters of dye and then injection (by turning the stopcock) of a small quantity of physiologic saline solution if toxic symptoms developed or if there was any doubt about the position of the needle in the vein.

While I was experimenting with the sodium salt of tetrabromphenolphthalein, we asked the Mallinckrodt Chemical Works to make the sodium salt. They did this very willingly, and my notes indicate that I injected the first commercial sodium tetrabromphenolphthalein on April 4, 1924. We fully expected that the use of this commercial preparation would eliminate the reactions, and were greatly disappointed when we discovered it did not; this was a source of considerable gratification to my ego as an amateur chemist.

MODIFICATIONS OF TECHNIC

Within two or three years there were dozens of modifications of the oral and intravenous methods, most of which appear absurd now and did so even then; I am not very proud of the fact that we contributed some of them ourselves.

As already mentioned, it was customary to omit breakfast and lunch after intravenous administration, although for a few years we gave a fat meal between the tenth and fifteenth hours to obtain radiologic evidence of emptying; with the oral method it was customary to omit breakfast and give a fat meal in the morning after the x-ray films were taken, provided a shadow of the gallbladder was obtained.

When the oral method was introduced, vomiting and diarrhea were common complaints, developing four to fourteen hours after ingestion of the capsules containing the media. To minimize these reactions, particularly the former, numerous workers including ourselves had the capsules coated with various substances (e.g., salol, phenyl salicylate and keratin) to keep them from dissolving in the stomach or dissolving too rapidly in the upper small intestine. Unfortunately the capsules often passed through the entire gastrointestinal tract intact; this was a very undesirable complication inasmuch as the amount of media absorbed might be insufficient to produce a shadow of a normal gallbladder. Fortunately, these undissolved capsules or pellets could be seen on the x-ray film, warning us that the test must be repeated. To prevent or minimize this failure of dissolution of the capsules, Levyn and Aaron [19] devised a method of using two capsules, one inside the other, with powdered sodium bicarbonate between the capsules; the cholecystographic media was contained in the inner capsule. The theory behind this modified procedure was that the sodium bicarbonate would prevent the formation of the hard insoluble acid form, which would be produced by

the acid in the stomach if the capsule dissolved in the stomach. We never tried this and do not know how effective it was. Larimore [20], working in our clinic, offered a suggestion which was quite effective in preventing formation of the insoluble acid powder on the outside of the content of the capsule, if the gelatin was dissolved in the stomach. He suggested filling capsules with three ingredients mixed in the following ratio: 0.8 gm. of tetraiodophenolphthalein, 0.1 gm. of powdered agar and 0.1 gm. of sodium bicarbonate. Filling the capsules with this mixture truly eliminated passage of "pellets" of media through the entire gastrointestinal tract before dissolution. To obtain the proper oral dosage of 4 to 5 gm. of tetraiodophenolphthalein, five or six capsules had to be ingested. One author reported that if 3 to 4 gm. of sodium tetraiodophenolphthalein were mixed thoroughly in a small bowl of cold cream of wheat, no media would be left unabsorbed, and a smaller dose of media was needed.

Fantus [21] contended that he was able to eliminate, for the most part, the nausea and vomiting, and the lack of absorption of the contrast media by giving it in a colloidal form. He passed carbon dioxide through a solution of sodium tetraiodophenolphthalein until it was discolored, or added carbonated water until a fine suspension was formed. To stabilize this suspension he added very dilute tragacanth mucilage. This colloidal suspension was white in color and did not have a disagreeable taste as did the regular powder. We tried this modification in technic and confirmed Fantus' claims; however, it was a bit too complicated to be adopted for routine use.

Early in our experience we tried rectal and duodenal administration of the media. The rectal mucosa was apparently greatly irritated, as indicated by severe tenesmus and diarrhea. Administration into the duodenum also resulted in diarrhea. Neither of these methods became popular. I also injected dilute sodium tetraiodophenolphthalein subcutaneously into rabbits, but I cannot understand why I wasted my time on such a procedure. I suppose I became so disturbed with the reactions following the oral as well as the intravenous methods of administration that I was grasping for straws, hoping the slower absorption following this method of administration would eliminate reactions. Strangely enough, shadows of the gallbladder were produced in several rabbits but, needless to say, we never tried it in human beings. I suspect we feared damage to local tissues, although we conducted some experiments shortly after we introduced the intravenous method and found that tissue slough would not be produced if the concentration of sodium tetraiodophenolphthalein was less than 8 per cent.

Naturally the introduction of the halogenated phenolphthaleins in cholecystography resulted in a flurry of efforts to find other drugs. Sabatini and Milani [22] reported that the oral administration of 10 to 20 gm. of sodium and strontium bromide would produce shadows of the gallbladder, provided the patient was fasted for a long period of time. This sounds like a very strenuous method and I do not know why we tried it. However, faint shadows of the gallbladder were obtained but the method was not satisfactory for routine use.

In an effort to eliminate the gastrointestinal symptoms following the use of the halogenated phenolphthalein compounds, Pribram [23] introduced a new drug called diiodocinchophen (diiodoatophan). We could easily guess what would happen in some of the patients receiving this drug. True enough, in many of the patients liver damage developed as indicated by the development of jaundice.

Kirklin and Kendall [24] introduced a new drug, diiodoethylether of disalicylphthalein, for use in oral cholecystography. Although shadows of normal gallbladders were obtained we did not expect it to be very effective since it contained only two iodine atoms, compared with four in tetraiodophenolphthalein. Apparently it was not used in many patients.

PROGRESS IN THE DEVELOPMENT OF NEW CHOLECYSTOGRAPHIC MEDIA

Sodium tetraiodophenolphthalein remained in universal use as an agent in cholecystography for many years after its development. However, in 1940 Dohrn and Diedrich introduced beta-(4-hydroxy-3,5-diiodophenyl)-alpha-phenylpropionic acid (Priodax®). Shortly thereafter numerous other agents including 2-(4-hydroxy-3,5-diiodo-benzyl)-cyclohexane carboxylic acid (monophen) and 3-(3-amino-2,4,6-triiodophenyl)-2-ethylpropanoic acid (Telepaque® or veripaque) were introduced. Still more recently the use of 3(3-butyrylamino-2,4,6-triiodophenyl)-2-ethyl sodium acrylate (bunamiodyl

or orabilex) has been reported. All of these are very effective compounds and are associated with few or no reactions. With the advent of these new compounds, tetrabromphenolphthalein, tetraiodophenolphthalein and phenoltetraiodophthalein were relegated to antiquity.

Acknowledgment: I am grateful to Wendell Scott of the Department of Radiology, Washington University, St. Louis, for accumulating some of my old notebooks used in recording certain early experiments and many bottles containing compounds used in these experiments for an exhibit displayed in the Mallinckrodt Institute. Dr. Hugh Wilson, Professor of Radiology at Washington University, St. Louis, kindly sent me some material from this exhibit which I needed for the preparation of this article. To Mr. Edward Mallinckrodt, Jr., Washington University and I are most grateful, indeed, for the Edward Mallinckrodt Institute of Radiology completed in 1931 and donated to Washington University. We like to think that the work on cholecystography might have been one of the factors stimulating Mr. Mallinckrodt to donate such a magnificent structure to medicine and to the people of St. Louis.

I wish to make it clear that the preparation of this article was not my idea. The Editor of *The American Journal of Surgery*, Dr. Robert Zollinger, asked me to do this several times, and I finally complied to protect myself from future "needling."

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The Surgical Implications of Unsuspected Ingested Foreign Bodies

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FOREIGN bodies are most frequently ingested by children or psychotic patients. The preoperative diagnosis is usually made without difficulty from the history and roentgenograms, since most ingested foreign bodies are radiopaque. During the past few years we have found unsuspected ingested foreign bodies in five adult, non-psychotic persons. Two patients presented with symptoms of intra-abdominal inflammation, one patient with symptoms suggestive of a benign tumor and two patients with symptoms of intestinal obstruction.

CASE REPORTS

CASE I. A thirty-two year old Negro man was first admitted to the Medical Service of the Philadelphia Veterans Administration Hospital on March 12, 1955. He gave a history of abdominal pain, anorexia, nausea and constipation of two days' duration. The pain was generalized at first, but later localized in the right lower quadrant. Appendectomy was performed the day after admission, and the patient was discharged on March 23. He was readmitted on April 21 with a history of mild cramps in the suprapubic area and left lower quadrant, and urgency of two days' duration. Temperature was 37.2°C., pulse rate 84 per minute and respiratory rate 20 per minute. Moderate tenderness was present in the left lower quadrant and in the suprapubic area. On rectal examination the seminal vesicles were found to be tender. The hemoglobin was 11.4 gm. per 100 ml. and the white blood cell count 4,500 per cu. mm. Urinalysis was negative for abnormalities. The patient was treated for seminal vesiculitis. Two days after admission he vomited brown fluid and food ingested several hours previously. Examination at this time revealed abdominal distention, muscle guarding in the left lower quadrant and suprapubic area, and rebound pain. The white blood cell count was 15,500 per cu. mm. X-ray examination revealed distention of mid-abdominal loops of the small bowel and the presence of fluid levels. This was reported as suggestive of ileus secondary to localized peritonitis, or early obstruction of the small bowel.

Laparotomy was performed and adhesions of the small bowel to the sigmoid colon were noted. When these were lysed, a toothpick was found lying between the loops of intestine. It was the impression of the surgeon that the toothpick had perforated the small bowel and penetrated the sigmoid. The wound was closed, and the patient had an uneventful postoperative course.

Comment: Abdominal surgery was performed with a preoperative diagnosis of acute diverticulitis because of a symptom complex suggestive of an inflammatory lesion with evidence of peritoneal irritation. The underlying cause was an unsuspected perforation of the small bowel by a toothpick.

CASE II. A seventy-one year old Negro man was admitted to the hospital on September 13, 1955, complaining of constant abdominal pain of three to four months' duration located to the right of the midline. Approximately two weeks prior to admission he noticed a slight tender mass in the right lower quadrant. He had had a weight loss of 8 to 10 pounds in the previous four months. His past history was non-contributory.

The significant physical finding was a firm, tender mass in the right lower quadrant about 7 cm. in diameter. Peristalsis was normal. Laboratory studies were within normal limits. A barium enema demonstrated extrinsic pressure on the right side of the sigmoid colon. Laparotomy disclosed a mass in the right lower quadrant adherent to the parietal peritoneum with a loop of small intestine attached. When this was dissected free, a fish bone was found. The mass was carefully separated from the parietal peritoneum. On microscopic examination it showed chronic suppurative inflammation. The patient had an uneventful postoperative course.

FIG. 1. Case III. Ovoid radiolucent defect apparently in duodenum with spasm of distal duodenum. (Defect located in antrum of stomach at surgery.) Spasm of duodenum secondary to duodenal ulcer.

Comment: This patient was operated upon with a preoperative diagnosis of carcinoma of the cecum. His symptoms were the result of perforation of the terminal ileum by a fish bone with secondary formation of granuloma. It was believed that adhesion of the small bowel prior to perforation by the fish bone prevented perforation into the free peritoneal cavity with resultant acute peritonitis. Instead of this, a chronic granulomatous reaction occurred.

CASE III. A sixty-one year old white man was admitted to the hospital on January 2, 1954, with a history of abdominal cramps and constipation of two weeks' duration. Appendectomy and cholecystectomy had been performed in 1917. Shortly thereafter an incisional hernia had developed which was repaired in 1923.

Physical examination showed no abnormalities. An upper gastrointestinal series revealed the presence of a mobile olive-shaped area of radiolucency. In the spot films, part of this mass seemed to be in the pyloric canal and suggested a pedicle. The roentgenologic diagnosis was prolapsed polyp. (Fig. 1.)

Gastrotomy was performed on February 2, 1954. A prune pit was found in the stomach and removed. There was marked narrowing of the pyloric canal. The patient had an uneventful postoperative course and was discharged on February 11, 1954. He was readmitted on March 9 with complaints suggestive of duodenal ulcer, which was demonstrated by an upper gastrointestinal series. He was treated conservatively, the symptoms were relieved and he was discharged. The patient had a recurrence of symptoms in May 1956 which again subsided with medical therapy.

Comment: The foreign body in this patient presented roentgenologically as a benign lesion, probably a gastric polyp. The roentgenologist, in discussing the roentgenographic findings preoperatively, suggested the possibility of a prune or peach pit.

CASE IV. A forty-seven year old white man was admitted to the Medical Service on April 1, 1954. He had a history of injury to the back resulting from a fall eleven days prior to admission. Two days before admission crampy epigastric pain had developed followed by vomiting. The vomitus was initially yellow, and later became dark. The patient also noted a lump under an upper abdominal scar, and stated that pressure on the mass relieved his pain. The patient had undergone subtotal gastrectomy in 1951 for chronic duodenal ulcer. On examination there was acute tenderness at the center of a midline epigastric scar. The abdomen was soft except for slight rigidity in the left upper quadrant. The entire abdomen was slightly tender, with rebound pain most marked in the epigastrium. Peristalsis was hyperactive and high-pitched, especially over the scar. Blood count, urinalysis and electrolytes were within normal limits. The serum amylase was 44 units. An obstruction series demonstrated loops of markedly dilated small bowel with fluid levels lying in the left upper and lower quadrants. There was no air in the large bowel. The radiologic diagnosis was obstruction in the distal jejunum or ileum. The patient was given intravenous fluids, and nasogastric suction was instituted through a long tube.

Laparotomy was performed through the old scar. The small bowel was distended to a point approximately 2 feet proximal to the ileocecal valve, where a freely movable sausage-shaped mass was felt in the lumen. The bowel beyond this area was collapsed. The mass could be moved to the ileocecal valve but would not pass through it. Ileotomy was performed, and a mass of yellow-orange material measuring approximately 7 cm. by 4 cm. was removed. The patient had an uneventful postoperative course. When told of the operative findings he remembered eating an orange without his false teeth and stated that "it got away from him."

Comment: The preoperative diagnosis in this patient was intestinal obstruction secondary to

intra-abdominal adhesions. One wonders how an orange could pass through a gastroenterostomy stoma.

CASE V. A forty-four year old Negro man was admitted to the Medical Service on February 14, 1955, with a four-week history of nausea, vomiting and diarrhea. The vomiting started suddenly, after which he was well for several days, then had intermittent vomiting and episodes of weakness until the day of admission. Approximately three weeks prior to admission, intermittent cramp-like lower abdominal pain and borborygmi developed, aggravated by food. Five days prior to admission he began to have watery bowel movements approximately five times a day. The stools were yellow, foamy and floating, but did not contain blood, pus or mucus. His past history was non-contributory.

The abdomen was slightly distended and there was tenderness in the right upper quadrant. There was no muscle guarding or spasticity, and peristalsis was normal. Urinalysis showed no abnormalities, hemoglobin was 9.3 gm. per 100 ml., hematocrit 35 per cent and white blood cell count 5,200 per cu. mm. The serum amylase was 40 units, serum lipase 0.33 units, and serum bilirubin 0.6 mg. per cent. A roentgenogram of the chest was within normal limits. An upper gastrointestinal series and a study of the small bowel were performed on February 17, 1955. A survey film of the abdomen demonstrated the presence of a collection of what appeared to be faceted calculi adjacent to the right transverse process of the second lumbar vertebra, and these were thought to be within the gallbladder. There was a moderate amount of gaseous distention of the small bowel, primarily in the right upper quadrant of the abdomen. Fluoroscopic examination of the esophagus, stomach and duodenal cap showed no abnormalities. The barium meal was observed for thirty hours. In that time there was demonstrated moderate but uniform distention of most of the loops of the small bowel down to and including the distal ileum. No air fluid levels were noted. In the films taken one hour after the ingestion of a meal, several calcific densities were seen in the right lower quadrant of the abdomen, and while these were thought to represent probably small masses of feces, the possibility of calculi in the loops of the small bowel could not be excluded. There was no significant amount of gas in the colon. The roentgenographic findings were considered to be consistent with incomplete obstruction, probably in the region of the terminal ileum. In view of the presence of calculi in the gallbladder, the possibility of a gallstone ileus was considered.

Laparotomy was performed on February 21, 1955. The entire bowel was distended but there was no evidence of obstruction. With a tentative diagnosis of adynamic ileus, further exploration was undertaken. A contracted gallbladder containing calculi and surrounded by adhesions was found. The gallbladder was removed by the Thorek technic, coagulating the posterior wall. For the first few days postoperatively the patient did well, then intermittent abdominal distention and vomiting developed. A long tube was passed and serial x-ray studies were performed. These showed progression of the tube, and many opaque calculi were seen distributed diffusely through the small bowel. On March 15 it was felt that the calculi had matted together in the region of the ileocecal valve and again a diagnosis of gallstone ileus was made.

On March 16 the cecum was delivered through a McBurney incision. It contained a large mass of firm, hard, foreign bodies although none was present in the terminal ileum. The appendix appeared to be involved in an inflammatory process. Appendectomy was performed, and the foreign bodies were removed from the cecum through the lumen of the appendiceal stump. An appendicostomy tube was inserted and the wound was closed.

Examination of the specimen showed it to consist of a number of dark ossified fragments, two of which could be identified as small bones by the presence of articular surfaces. Another bone fragment was identified as a small vertebral body, complete with lateral spines, a neural arch and neural canal. Other fragments included seeds and two concretions which resembled faceted calculi. Two small fragments of glass were also identified, each of which measured approximately 0.8 cm. in its longest diameter. (Fig. 2.)

The patient had an uneventful convalescence. The tube was removed on March 29. The patient gained weight but the appendicostomy failed to close despite normal bowel movements per rectum. A barium enema on May 2, 1955, demonstrated complete obstruction at the distal ascending colon. Barium administered through the opening of the cecostomy delineated numerous diverticuli in the mid-ascending colon. Insufficient barium entered this area, however, for any statement to be made as to the nature of the obstruction. The possibility of obstruction due to diverticulitis was suggested, although the presence of neoplasm could not be ruled out. On May 17 another laparotomy was performed. A clinical diagnosis of carcinoma of the ascending colon was made, and right hemicolectomy was performed with end-to-end ileotransverse colostomy. Following this the patient had an uneventful postoperative course.

Comment: The preoperative diagnosis at the time of the first two laparotomies was intestinal obstruction secondary to gallstone ileus. This diagnosis was suggested by the presence of opaque bodies in the gastrointestinal tract and

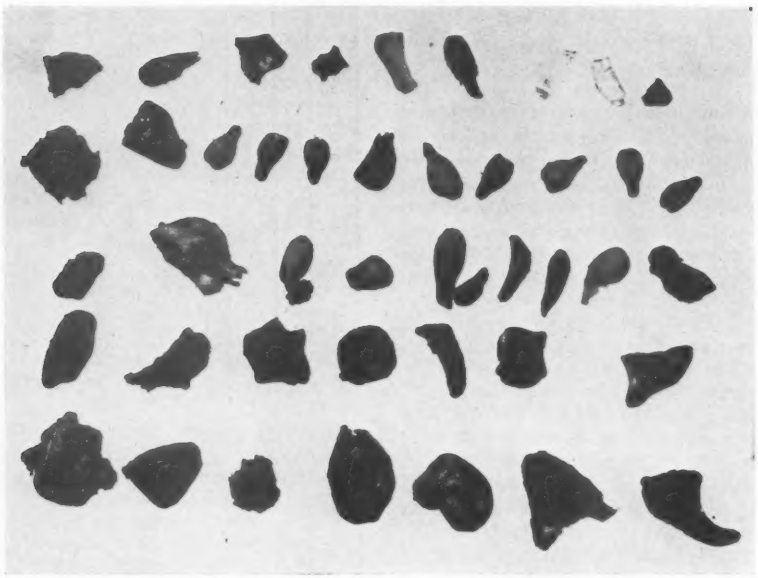

FIG. 2. Case v. Foreign bodies consisting of bones, slate and glass.

calculi within the gallbladder. The primary lesion, an adenocarcinoma of the hepatic flexure, was not found at the time of initial laparotomy, although careful exploration was performed, but was suspected only after failure of the appendicostomy to close.

COMMENTS

Most ingested foreign bodies do not present a problem of diagnosis or treatment. About 80 per cent of ingested foreign bodies pass spontaneously [2,5]. A foreign body may pass through the gastrointestinal tract without producing symptoms. However, symptoms may appear as a result of obstruction, when chronic granuloma secondary to irritation of the mucosa develops, or when perforation is impending. The patient may be unaware of the ingestion of a foreign body unless it lodges in the larynx, pharynx or esophagus. When medical advice is sought, the patient's symptoms are rarely associated in his mind with the incident and, in our experience, recollection of the incident has been absent.

The symptoms produced are variable and dependent upon the complications. They may be those of an acute surgical condition of the abdomen as a result of perforation and peritonitis. St. John [6] presented one case of perforation of the intestinal tract by a toothpick, and reviewed the literature concerning such perforations. Markle [3] reported on a seventy year old woman with perforation of the ileum by a chicken bone. Alhadeff [1] presented a case of perforation of a Meckel's diverticulum due to a wood splinter, and reviewed twenty-five other cases of perforation of Meckel's diverticulum by a foreign body.

Foreign bodies may mimic intra-abdominal tumors. Vaughn and Rooney [7] discussed the problem of a forty-one year old white man, with symptoms and x-ray findings suggestive of duodenal ulcer, who was treated conservatively without benefit. At surgery a mass was found on the greater curvature of the stomach, 3 to 5 cm. from the pylorus. It had the appearance of a malignant ulcer, and biopsy of a gastrocolic node was suggestive of metastatic gastric carcinoma. Subtotal gastric resection was performed. Pathological examination revealed a pin or wire 8 mm. long, penetrating the wall of the stomach. There was no evidence of gastric carcinoma.

The symptoms of an ingested foreign body may also resemble those of acute intestinal obstruction. Ottley [4] presented the case of a sixty-one year old woman with intestinal ob-

struction. At laparotomy a tumor was palpated in the ileum and resection performed. Pathologic examination revealed a granuloma surrounding a piece of wire.

Wolf [8] in 1956 presented six cases in which fruit pits (plum, prune and apricot) acted as foreign bodies. In two patients the pit was trapped at the cricopharyngeal sphincter in the neck and was removed endoscopically; the pit was located in the stomach in three patients and in the ileum in one, and all were removed surgically. He described the roentgenographic features of fruit pits as showing an intraluminal filling defect with characteristic intrinsic radiological findings. These include a characteristic fixed and unchangeable elliptic shape, radiolucent areas within the filling defect as a result of contained air, and a soft center. Characteristically the air in the pit forms a radiolucent band or rim a short distance from the outer margin and parallel to it, and there are other lucent areas in the center of the pit. The geometric pattern produced by the aforementioned findings does not occur with an organic lesion such as a polyp.

When surgical intervention is required, the diagnosis of foreign body is usually made preoperatively. Obstruction is frequently produced when the foreign body is blocked at a site of primary intestinal disease. It is emphasized that a distal intestinal pathologic condition should always be suspected when obstruction occurs with a foreign body.

SUMMARY

1. Approximately 80 per cent of all ingested foreign bodies will pass spontaneously without symptoms.

2. The unsuspected ingested foreign body may present symptoms suggestive of intraperitoneal inflammation with or without peritonitis, tumefaction or intestinal obstruction.

3. Our experience with five non-psychotic adult men is presented, illustrating these complications of unsuspected ingested foreign bodies.

4. The x-ray findings of the ingested fruit pit are presented; they are believed to be almost pathognomonic of this particular condition.

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Roentgenographic Diagnosis of Structural Deviations in the Lumbosacral Spine of Persons Engaged in Heavy Industry

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PRE-EMPLOYMENT physical examinations have been used in industry for the past fifty years. Roentgenographic examination of the lumbosacral spine as part of the pre-placement program for industrial workers is becoming more common. The medical literature contains reports on the value of preplacement examination of the lumbar spine by Allen and Lindem [*1*], Barton and Biram [*2*], Becker [*3*], Breck, Hillsman and Basom [*4*], Colcher and Hursch [*5*], Coulter [*6*], Cushway and Maier [*7*], Moreton, Winston and Bibby [*9*], Runge [*10*] and Stewart [*11*].

The study of the low back by x-ray films has been a part of the pre-employment examination of candidates seeking employment at an industrial plant employing approximately 5,000 men. The purpose of this study is to determine and tabulate the defects and anatomical variations seen in a large group of supposedly normal working men.

The material for this paper consists of the results of 6,748 examinations made between June 1, 1950 and July 1, 1956. A previous series of 3,000 cases was studied between June 1, 1948 and June 1, 1950 [*1*].

Roentgenograms were routinely taken in anteroposterior and lateral projections. The lower two thoracic vertebrae and at least the upper three sacral segments were included. For economic reasons, additional films, such as cone-down and oblique views of the lumbosacral joint, were taken only in special cases. The lateral films were taken with the legs extended in order to obtain as true a measurement of the lumbosacral angle as possible with the patient in the recumbent position. Ferguson [*8*] has stated that the lumbosacral angle should be measured with the patient in the recumbent position.

RESULTS

This paper is an analysis of structural deviations found in the roentgenograms of the lumbosacral spine of 6,748 men ranging in age from eighteen to seventy-two years. The results of 4,291 examinations were considered to be normal, 1,929 had a single defect and 528 had two or more abnormalities. Architectural defects have been tabulated under the following main groups: (1) congenital anomalies, (2) postural malalignments, (3) post-traumatic and degenerative changes, (4) postsurgical changes, (5) infectious residuals and arthritis, and (6) miscellaneous conditions.

Congenital Anomalies (*Tables I to III*). Spondylolysis, with or without accompanying spondylolisthesis, was found in 171 patients

TABLE I
CONGENITAL ANOMALIES

	No. of Cases Showing Abnormality	Per cent of Total
Spina bifida occulta	767	11.4
Transitional vertebra	520	7.7
Spondylolysis	171	2.5
Spondylolisthesis	96	1.4
Ununited ring epiphysis	21	0.4
Block vertebra	4	0.1
Total	1,579	23.5

TABLE II
CONGENITAL ANOMALIES: SPONDYLOLYSIS

Age Group	No. of Cases	No. of Cases with Spondylolysis	Incidence (%)
15–19	1,138	29	2.55
20–24	1,692	36	2.13
25–29	1,234	28	2.27
30–34	852	19	2.23
35–39	737	25	3.39
40–44	500	10	2.00
45–49	296	12	4.00
50–54	181	8	4.42
55–59	63	1	1.60
60 and over	55	3	5.45

TABLE III
CONGENITAL ANOMALIES: SPONDYLOLISTHESIS

Age Group	No. of Cases	No. of Cases with Spondylolisthesis	Incidence (%)
15–19	1,138	14	1.23
20–24	1,692	12	0.71
25–29	1,234	19	1.54
30–34	852	14	1.67
35–39	737	13	1.78
40–44	500	7	1.40
45–49	296	9	3.04
50–54	181	7	3.87
55–59	63	0	0.00
60 and over	55	1	1.82

(2.5 per cent). In ninety-six of these men, spondylolisthesis was also present. Allen and Lindem [1] reported spondylolisthesis in 2.96 per cent of 3,000 pre-employment examinations. The defect involved the pars interarticularis of the last lumbar vertebra most commonly. Spondylolisthesis is often, but not always, associated with an acute lumbosacral angle and narrowing of the lumbosacral space with associated eburnation and hypertrophic change of the adjacent cortices of the body of L5 and the sacrum.

Other congenital anomalies found include spina bifida occulta. This condition was noted in 767 patients (11.4 per cent). The last lumbar vertebra and first sacral segment were most frequently involved. No attempt was made to determine whether the transitional vertebra represented sacralization or lumbarization. Twenty-one cases of ununited ring epiphyses were found. They usually occurred at the level of L3 or L4. Variations in the size and asymmetry of the articular processes in the lumbosacral region were commonplace but not tabulated. The asymmetry sometimes produced a slight scoliosis. Ununited epiphyses of the transverse processes of L1 and rudimentary ribs were frequently observed but not tabulated.

Postural Malalignments. Two hundred fifty cases of scoliosis were recorded. Minimal deviations of the spine from the midline were not listed. The lumbosacral angle was determined on the lateral film. The angle formed by a line drawn across the superior surface of the first sacral segment and the horizontal was considered the lumbosacral angle, after the method of Ferguson [8]. After measuring 4,507 lumbosacral angles, 50 per cent were found to fall between 40 and 50 degrees, and 95 per cent of the angles measured were within the range of 30 to 60 degrees. (Table IV.)

Post-traumatic and Degenerative Changes. Hypertrophic changes were present in 624 cases. (Table V.) The extent varied from moderate localized spur formation to extensive generalized bony bridging. No attempt was made to differentiate between the mild and severe cases. As expected, the per cent of persons having hypertrophic changes increased sharply with increasing age.

The most common post-traumatic lesions were compression fractures of the vertebral body. (Table VI.) One hundred twenty-six cases were found; some were multiple fractures. The

TABLE IV
LUMBOSACRAL ANGLE (IN DEGREES) AS MEASURED ON 4,507 LATERAL FILMS

Degrees	No. Cases
15–19	5
20–24	40
24–29	110
30–34	386
35–39	877
40–44	1,131
45–49	1,103
50–54	582
55–59	193
60–64	55
65–69	16
70–74	8
75–78	1

TABLE V
HYPERTROPHIC CHANGES

Age Group	No. of Cases	No. of Cases with Hypertrophic Change	Incidence (%)
15–19	1,138	9	0.79
20–24	1,692	16	0.94
25–29	1,234	21	1.70
30–34	852	56	6.56
35–39	737	102	13–84
40–44	500	125	25.00
45–49	296	124	41.90
50–54	181	88	43.08
55–59	63	48	76.20
60 and over	55	35	63.63
Total....	6,748	624	.....

levels of D11, D12 and L1 were most frequently involved.

Narrowed interspaces were noted in 239 cases. Of these, the last lumbar space was involved 196 times. (Table VII.) Excluded from our tabulations were the narrowed interspaces associated with transitional vertebrae. Since there is a considerable anatomical variation in the width of the lumbosacral space, narrowing of the space was not tabulated unless associated with formation of osteophytes and/or sclerosis of the adjacent vertebral bodies or vacuum phenomenon. Posterior displacement of the fifth lumbar body on the sacrum was occasionally associated with thinning and narrowing

TABLE VI
FRACTURES OF THE VERTEBRAL BODY

Age Group	No. of Cases	No. of Cases with Fracture of Vertebral Body	Incidence (%)
15–19	1,138	14	1.23
20–24	1,692	22	1.35
25–29	1,234	28	2.27
30–34	852	21	2.46
35–39	737	17	2.31
40–44	500	8	1.60
45–49	296	7	2.43
50–54	181	6	3.26
55–59	63	1	1.60
60 and over	55	2	3.64
Total....	6,748	126	....

TABLE VII
INTERVERTEBRAL SPACE AT L5 AND S1 REDUCED

Age Group	No. of Cases	No. of Cases with Reduced Interspace	Incidence (%)
15–19	1,138	8	0.70
20–24	1,692	19	1.12
25–29	1,234	13	1.05
30–34	852	17	2.00
35–39	737	30	4.07
40–44	500	29	5.80
45–49	296	41	14.00
50–54	181	20	11.05
55–59	63	9	15.89
60 and over	55	10	18.18
Total....	6,748	196	.....

of the intervening disc space. Reduced intervertebral spaces and hypertrophic changes were much more numerous in the older age groups.

Other post-traumatic and degenerative changes were Scheuermann's disease noted in twenty-three cases, and 156 cases of Schmorl's nodes mostly involving the lower dorsal and upper lumbar vertebrae. Fractures of the transverse processes were observed in ten cases. (Table VIII.)

Postsurgical Changes. Surgical spinal fusion was present in forty cases, and retained contrast media from previous myelographic examination was noted in twenty-four cases. (Table IX.)

Infectious Residuals and Arthritis (Table X). Nineteen cases of sacroiliac arthritis and thirty-three cases of arthritis of the apophyseal joint were noted.

TABLE VIII
POST-TRAUMATIC AND DEGENERATIVE CHANGES

	Cases	Per cent of Total Examinations
Vertebral body fracture.....	126	1.8
Transverse process fracture....	10	0.15
Schmorl's nodes.....	156	2.2
Hypertrophic changes.....	624	9.4
Reduced intervertebral space...	239	3.5
Scheuermann's disease.....	23	0.3
Osteoporosis.....	10	0.15
Total.....	1,188	17.50

TABLE IX
POSTSURGICAL CHANGES

	Cases	Per cent of Total Cases
Spinal fusion	40	0.6
Media from previous myelogram	24	0.3
Total	64	0.9

Only two cases of advanced Marie-Strümpell arthritis and two cases of probable tuberculosis of the vertebrae were found.

Miscellaneous Conditions. Vertebral hemangiomas were noted twice, and Paget's disease was found twice. Deossification and osteoporosis of unknown etiology were noted ten times. In addition to bone lesions, several lesions of soft tissues were seen, such as gallstones, atherosclerosis of the aorta, ureteral and renal calculi, calcified renal cysts and calcified mesenteric lymph nodes.

COMMENTS

The basic question that every industrial surgeon asks is, What defects should be cause for rejection of a job applicant or for limited employment? Moreton, Winston and Bibby [9] have recently reported 150 instances of back complaints which were prepared for ligation. Eighty-one per cent involved complaints referable to the low back associated with major defects of the spine noted on pre-placement films. Additional studies of the relationship between structural defects and a man's work record are urgently needed. Until such studies have been made, the industrial surgeon must evaluate each structural defect on the basis of its severity in accordance with his own experience with each type of defect.

Those applicants who were found to have serious architectural defects of the spine, and who were required to have physical ability to handle considerable, varied and unpredictable work effort, were rejected. Each case, however, was considered individually and the applicant rejected only if the structural defect was such that the employment sought was likely to be detrimental to the employee and his fellow workers. Roentgenographic evidence of extensive trauma, degenerative changes, severe congenital defects, postsurgical or postinfectious residues have disqualified approximately 7 per cent of those applying for work. (Table XI.)

TABLE X
INFECTIOUS RESIDUALS AND ARTHRITIS
(OTHER THAN HYPERTROPHIC CHANGES)

	No. of Cases
Sacroiliac arthritis	19
Apophyseal arthritis	33
Marie-Strümpell arthritis	2
Tuberculosis of vertebral body	2
Total	56 (0.85%)

TABLE XI
SUMMARY

	No. of Cases	Per cent of Total Cases
Congenital anomalies	1,579	23.5
Post-traumatic and degenerative changes	1,188	17.5
Postsurgical changes	64	0.9
Infectious residuals and arthritis	56	0.8
Miscellaneous conditions	33	0.4

Films taken during the pre-employment examination become a permanent record, and form a base line to protect the employer from liability for pre-existing conditions in the event of later strain or trauma in the course of employment.

SUMMARY

1. Lumbosacral roentgenographic examinations of prospective employees numbering 6,748 are reviewed. The results of 4,291 examinations were considered to be normal, 1,929 showed a single defect; and 528 showed two or more abnormalities.

2. Architectural defects are tabulated according to age under the following groups: congenital anomalies, postural malalignments, post-traumatic and degenerative changes, postsurgical changes, infectious residuals and arthritis, and miscellaneous conditions.

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CASE REPORTS

Diverticula of the Duodenum

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THE question of surgical intervention for a duodenal diverticulum can pose a serious problem to a surgeon. A survey of some of the literature on this subject will leave the reader somewhat perplexed as to when to operate upon such a patient and what procedure to employ.

Allen and Harkins [*1*] clearly define the true pulsion diverticulum where the mucosa protrudes through the muscularis as the primary type. The secondary type, or clover-leaf traction diverticulum, is a secondary result of duodenal ulcer.

As to the incidence of this lesion, Glasier and Corbet [*2*] report on a series of 10,197 gastrointestinal x-rays with the finding of eighty duodenal diverticula (an incidence of 0.8 per cent). Ackerman [*3*] studied fifty cadavers in which he ligated the duodenum at the pylorus and ligament of Treitz and injected barium into the duodenum, finding a twenty-two per cent occurrence of duodenal diverticula. We concede the importance of this work but doubt its relation to incidence in the living patient.

The most frequent site for this disorder is in the descending loop of the duodenum, followed by the third part, and very rarely the first part of the duodenum. These diverticula always arise on the concave side of the duodenum and may extend under the head and the body of the pancreas.

Although it is conceded that the vast majority produce no symptoms, there is a small group which will produce symptoms simulating other more common conditions in the upper portion of the abdomen. Beaver [*4*], Boland [*5*], Luciniano [*6*], Monsarrat [*7*], and Glasier and Corbet [*2*] report cases of perforation of an acute ulcer in a duodenal diverticulum. Hare and Cattell [*8*] report a case simulating gallbladder colic. Marshall [*9*] and Finney [*10*] discuss duodenal hemorrhage from active ulcers in a diverticulum.

However, most patients have been operated upon after diagnosis by exclusion. The most frequent symptoms are nausea, vomiting, mid-epigastric cramping pain associated with a long history of diagnostic procedures, medical treatment and, not infrequently, previous unsuccessful surgery of the upper portion of the abdomen.

Although intermittent jaundice with obstruction of the common duct and cholangitis, as well as acute and chronic pancreatitis, have been reported as caused by duodenal diverticula by Wilbur and associates [*11*], it seems doubtful to me that a duodenal diverticulum, exclusive of acute inflammation within the diverticulum, can produce such symptoms. We would be very wary of arriving at such a diagnosis preoperatively.

Blegen and Swanberg [*12*] report a case in which the common bile duct entered the diverticulum; they treated this patient with gastric resection of the Bilroth II type and implantation of the common duct into the duodenal stump. The necessity for this extensive procedure is highly questionable. Catell and Mudge [*13*] report seventeen cases in which nine patients were improved, three had fair results and five had poor results. Waugh and Johnston [*14*], from a series of *525* x-ray diagnoses, operated upon thirty patients. In eight

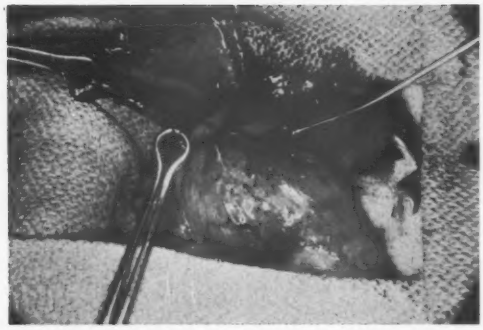

FIG. 1. Probe indicates proximity of common duct to neck of diverticulum.

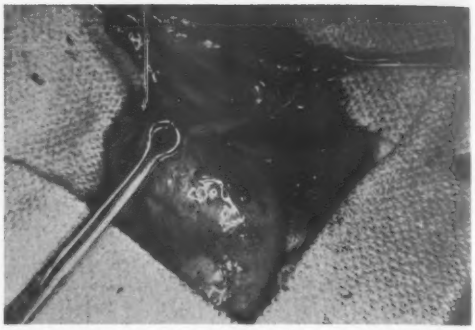

FIG. 2. Probe indicates position of ampulla of Vater.

of the thirty, exploration was for the diverticulum. They removed seventeen diverticula and inverted two, but conclude that only one-half of the patients were relieved. They also had two deaths and one subhepatic abscess from a duodenal fistula. They concluded that 1 to 2 per cent of patients with diverticula noted on x-ray films should be operated upon. Only one-half are relieved but there is no way to know which half are to be chosen.

Zinninger [*16*] sums up the indications for operation, "In those instances in which the diverticulum is large and retains barium for twenty-four hours or longer and in which no other cause for the patient's symptoms can be demonstrated, operation for removal of the diverticulum is indicated."

It is the general opinion of all authors that the symptomatic diverticulum occurs in persons in the age group of fifty years and more.

There are three surgical approaches to the problem, only two of which are accepted in present day surgery. The first procedure of occluding the pylorus by ligation with a fascial strip and diversion of the intestinal flow by gastroenterostomy, as described by Bartlett, is not an acceptable procedure today. Ferguson and Cameron [*15*] recommend inversion of the sac after it has been isolated with closure of the muscularis. The most acceptable approach is dissection of the sac, followed by its removal, closure of the mucosa and repair of the muscularis.

CASE REPORTS

CASE I. Mrs. V. A., a seventy-three year old white woman, had been suffering from nausea and vomiting and epigastric pain for approximately one year. In the course of diagnostic procedures the stomach and gall bladder were found to be normal but a duodenal diverticulum of the second portion of the duodenum was noted. Further x-ray studies indicated a constriction of the hepatic flexure of the colon and a presumptive diagnosis of carcinoma was made. The patient had lost about 30 pounds in weight.

The patient was operated upon following the diagnosis by x-ray film, and upon incising the abdomen the colon was found to be normal. The stomach and gallbladder were normal. The duodenal peritoneum was incised laterally, and the duodenum was turned medially exposing a large diverticulum about 6 cm. in length arising from the medial side. This was easily freed by sharp and blunt dissection until the neck was located. The common duct lay beside the neck. (Fig. 1.) The diverticulum extended out from the separated layers of the muscularis at the neck. The sac was opened and the ampulla of Vater located. (Fig. 2.) The sac was removed at its neck which was closed with No. 2-0 intestinal chromic suture. Then the muscularis was closed over the neck with No. 3-0 silk suture and the duodenum allowed to drop back into position. The abdomen was closed in a routine manner with no drains. A Levin tube with suction was used for three days with appropriate supportive intravenous fluids. The patient made an uneventful recovery. Nausea, vomiting and pain ceased. She regained her appetite and most of her weight. She has had no further complaints.

CASE II. Mrs. E. C., a seventy-five year old white woman, entered the hospital because of nausea, vomiting, some weight loss and jaundice. After a thorough diagnostic work-up she was found to have two duodenal diverticula, a gallbladder containing one stone and, by means of intravenous Cholografin,® one stone in the common duct.

She was operated upon January 22, 1958, at which time the gallbladder was removed, the common duct explored and one stone removed.

The duodenum was rotated medially and a large duodenal diverticulum dissected away from the medial aspect of the duodenum. This was opened, the ampulla located and another diverticulum was found which ran about 6 cm. under the head and body of the pancreas. It was believed that to remove this one would jeopardize the safety of the patient and accomplish nothing but a satisfaction to the surgeon. The neck of the sac of the first diverticulum was closed with No. 2-0 chromic sutures and the muscularis with silk sutures. A T tube was used in the common duct.

With the usual treatment postoperatively, a normal convalescence was obtained. The patient is well and free of symptoms.

CASE III. C. C., a sixty-seven year old white man, was admitted to the hospital because of increasing distress and pain in the right upper quadrant following ingestion of food, particularly exacerbated by fat foods. A diagnostic evaluation revealed a non-filling gallbladder with probable stones and a diverticulum of the descending limb of the duodenum.

He was operated upon October 13, 1958, at which time a chronically thickened and inflamed gallbladder containing several large stones was removed. The common duct was normal in size and was not explored. The duodenum was mobilized to the left, and a long, thin, duodenal diverticulum was dissected from the underlying pancreas. It was composed of mucosa alone and arose from the medial side of the duodenum through a separation of the muscularis just distal to the ampulla of Vater. The diverticulum was severed at its base after putting a probe in the ampulla up the common duct to visualize and protect the common duct. The mucosa was closed and the muscularis defect was closed over the mucosa. The abdomen was closed routinely with a stab wound drain to the foramen of Winslow.

The patient made an uneventful recovery and was home on the seventh postoperative day. He has remained well and symptom-free since that time.

COMMENTS

These three cases illustrate the surgical findings in duodenal diverticula. One patient was relieved of her symptoms by resection. The other patient had what we believe to be asymptomatic diverticula associated with symptoms of common duct obstruction. The third patient had his diverticulum removed as a concomitant surgical anomaly associated with chronic cholecystitis.

SUMMARY

Symptomatic duodenal diverticulum is a rare surgical entity, the diagnosis of which is generally made by exclusion. Operation is indicated when no other disease will account for the particular symptoms. Anatomically, the close proximity of the common duct requires careful attention to the dissection and closure of the defect. Three cases are presented, one patient with symptoms and two with other symptomatic disease, all of whom had resection of the diverticula without added morbidity or mortality. It would seem advisable to remove a duodenal diverticulum at the time of other surgery if it does not add to the surgical risk.

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Cushing's Disease

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CUSHING'S syndrome was first described by Dr. Harvey Cushing in 1932. It was his opinion that most of these cases were due primarily to basophil tumors of the anterior pituitary gland. However, during the years, this opinion has gradually been reversed, and it is now conceded that the disease is primarily of an adrenal cortical origin and only a small number of cases are secondary to pituitary disease [1]. Some authors even believe that the disease begins primarily in the adrenal cortex and that pathologic changes occur secondarily in the anterior pituitary. Hyaline changes in the basophilic cells of the pituitary have been seen in patients given large doses of cortisone [2]. We are presenting a case of Cushing's syndrome which illustrates the classic symptoms and signs and in which total adrenalectomy reversed organic abnormalities due to several years of hyperadrenalism.

FIG. 1. Snapshot of the patient taken in 1949 before his illness.

CASE REPORT

A forty-one year old white man was admitted to the Surgical Service, V. A. Center, Whipple, Arizona, on January 21, 1958. He complained of swelling, tenderness and multiple ulcers on the lower part of his left leg. These symptoms began three weeks prior to admission with tenderness in the left calf which was followed by rather marked edema and eventual ulceration at the malleolar area.

The patient was a veteran of World War II and the Korean conflict. In World War II, he had been assigned to the Paratroopers as an athletic instructor. He had prided himself on his physical strength and agility. (Fig. 1.) For about five years before this admission, he had noticed increasing weakness, transient edema of the face, and swelling of the abdomen. There had also been progressive loss of libido and sexual potency. He consulted a physician for these complaints and was told at least three years before admission that he had hypertension. In 1956, he was in an automobile accident and suffered a fractured pelvis. The history was difficult to obtain because of the patient's inability to concentrate and his poor memory.

At the time of admission, examination disclosed the patient to be acutely ill, the lower part of his left leg was markedly swollen from the toes to the knee. Over the medial malleolar area, there was a confluence of ulcers measuring 6 to 7 cm. with several small ulcers in this area. A thick, dirty pus, greenish yellow in color exuded from the ulcers. The left calf was markedly tender, and Homan's sign was positive. Left inguinal adenitis was present. The patient's general appearance was strikingly bizarre. His face was moonshaped with a dark reddish flush that continued to the upper

FIG. 2. Preoperative view of the patient showing the typical moonface, truncal obesity, and abdominal striae of Cushing's syndrome.

FIG. 3. Preoperative lateral view showing striae of the abdomen and thigh.

part of his chest. A pronounced fat pad was noted in the cervicodorsal region. The arms were thin, the body obese with violaceous striae over the lateral lower part of the abdomen, and a dusky coloration involving the lower part of the abdomen and the upper part of the thighs. (Figs. 2 and 3.) There was questionable ascites, the right leg was edematous but less so than the left. There was marked dorsal kyphosis; the heart was enlarged to the left; there were no murmurs; and physical examination of the chest was within normal limits. The retinal vessels were normal. Blood pressure was 172/115 mm. Hg, and the patient's weight was 157 pounds.

Laboratory findings on admission disclosed a hematocrit of 31 per cent; white blood cells, 9,500 per cu. mm.; neutrophils, 89 per cent; lymphocytes, 11 per cent. Urinalysis showed 1-plus albumin and was negative for sugar. Blood urea nitrogen was 21 mg. per cent; sodium, 140 mEq. per L.; potassium, 3.5 mEq. per L. A roentgenogram of the chest taken on admission showed a markedly enlarged cardiac shadow with prominence of the aorta and moderate pulmonary congestion particularly in the bases. An electrocardiogram showed left ventricular hypertrophy and ischemia. An additional x-ray finding was evidence of old fractures of the left ribs. The initial impression was acute thrombophlebitis of the lower part of the left leg with cellulitis and ulcer formation, and hypertensive heart disease.

Active treatment was begun immediately for the thrombophlebitis, and this consisted largely of bed rest, the administration of anticoagulants and antibiotics, together with saline soaks to the ulcerated leg and a heat cradle. In addition, several blood transfusions were given because of the anemia. The patient responded slowly to this therapy. Wound culture disclosed gram positive diplococci, and appropriate antibiotics were given. Eventually, the purulent discharge from the ulcers was brought under control, and the patient was taken to the operating room; the lower part of the left leg was thoroughly débrided. This débridement was followed during the next several weeks with three separate skin grafting procedures during which postage-stamp grafts were applied to the large raw areas of the lower part of the left leg resulting from the marked slough following the patient's thrombophlebitis. Eventually all the ulcers and granulated areas were covered, but it was the operator's opinion that the patient's healing powers were markedly diminished.

Hypertension and albuminuria were persistent. The diastolic pressure at times reached 130; the pressure averaged 180/110 mm. Hg. By March, the weight had increased to 175 pounds, and there was marked edema of the back and legs and definite ascites and hepatomegaly. The heart had further

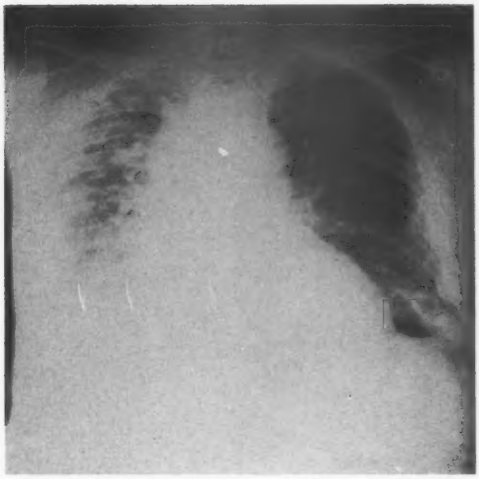

FIG. 4. The chest roentgenogram taken on March 20, 1958 shows marked cardiac enlargement, patchy infiltration and pleural effusion on the right. The left fourth anterior rib at the costochondral junction shows the mushroom appearance described in the test.

enlarged, and extensive infiltrations were noted in the right lung. These were thought to be due to pulmonary congestion or pulmonary infarction. Urine specimens obtained at random showed sugar. Fasting blood sugars were normal, but two hour postprandial specimens ranged from 200 to 260 mgm. per cent. The patient's mental condition had also regressed; he became quite depressed, and was seen by the psychiatrist because of the question of suicidal possibilities. The patient was digitalized March 24, and maintenance dosage of Digoxin® continued. He was also placed on a low salt diet with potassium supplements. At this time, the possibility of hypercorticism was considered, and appropriate studies were initiated. On March 28, the serum sodium was 151 mEq. per L.; potassium, 3.6 mEq. per L.; and CO_2, 30 mEq. per L. The total eosinophil count was 11 per cu mm. The 17-hydroxycorticoids in the urine were 10.3 mgm. per twenty-four hours on March 26, 1958, and 33.4 mg. per twenty-four hours on May 5, 1958. The normal value is 3.5 to 11.5 mg. in twenty-four hours. The 17-ketosteroids in the urine were 11.5 mg. in twenty-four hours on March 26, 1958, and 19.7 mg. in twenty-four hours on May 5, 1958, the normal values being 8 to 22 mg.* Numerous serum electrolyte studies showed a persistently high value for sodium, reaching as high as 153 mEq. per L., and slightly low potassium levels, the lowest value being 3.5 mEq. per L. The CO_2 combining power was consistently elevated, the highest reading being 31.5 mEq. per L. An x-ray bone survey on March 25 showed compression fractures of T_{12} and L_5, and incompletely healed fractures of the pubic rami. Also, generalized osteoporosis was noted. In addition, changes in the ribs, which had been described as pathognomonic of Cushing's disease by Sussman and Copleman [3], were noted. (Fig. 4.) These changes occurred at the anterior ends of the lower rib just lateral to the costochondral junction, and consisted in an expansion of the rib to about twice its normal size in this area for a distance of about 1 inch and a homogenous increase in density. These areas were suggestive of callus formation associated with healed fractures. Calcium and phosphorous studies were normal, but the alkaline phosphatase level was 16.6 Bodansky units on May 5.

Attempts at diuresis with mercurial diuretics were not successful, but the use of diuril (chlorothiazide) was more effective although some edema persisted. Reserpine and Apresoline® treatment previously given was discontinued.

During April, slight jaundice was noted, and serum bilirubin rose to 3.7 mg. with a positive direct reaction. Urine urobilinogen was increased, and fecal urobilinogen slightly increased. Thymol turbidity, cephalin flocculation, and transaminase were normal. X-ray studies of the adrenal glands by presacral injection of carbon dioxide showed an apparently enlarged left adrenal gland.

The patient's general condition reached a stable state during the course of treatment with digoxin, diuril, low salt diet, and potassium supplement. The impaired glucose tolerance was not a problem in treatment, requiring only avoidance of concentrated carbohydrates in the diet. The blood pressure remained elevated, the heart enlarged, moderate edema remained, and there were persistent pulmonary rales.

The electrolyte pattern of high sodium, low potassium and elevated CO_2 combining power was unchanged. The patient's weight had fallen to 150 pounds. Areas of the left leg continued to drain. The diagnosis of hypercorticism seemed established, and it was believed that further improvement could not be expected until the hypersecretion of cortical steroids was abolished by surgery.

In the adult, about 60 per cent of the cases of Cushing's syndrome are due to bilateral adrenal cortical hyperplasia and 30 per cent to a malignant or benign tumor. In about 10 per cent of the cases, no change in the adrenal cortex, gross or microscopic, can be detected [2]. If a functioning adrenal tumor is responsible for the syndrome then the opposite adrenal will be atrophic, and after removal of the tumor, the atrophic gland may resume normal function. The differential between adrenal tumor and bilateral hyperplasia may sometimes be

* Steroid determinations were performed by the V. A. Area Reference Laboratory, San Francisco, California.

made presurgically by: (1) radiological investigation, (2) pattern of the urinary excretory levels of 17-ketosteroids and 17-hydroxycorticoids, (3) the response of urinary steroid output to exogenous intravenous ACTH stimulation. Elevation of urinary levels of 17-hydroxycorticoids with normal or low levels of 17-ketosteroids usually indicates hyperplasia as the cause of Cushing's syndrome. In bilateral hyperplasia, a markedly increased urinary output of 17-ketosteroids and 17-hydroxycorticoids result from ACTH stimulation. A normal or moderate response is noted in adenoma, and no response in carcinoma since a malignant tumor is autonomous and not under the control of adrenocorticotrophin. An ACTH stimulation test was not attempted in our patient because it was thought that the test might further impair the patient's already poor general condition.

The patient was scheduled for surgery on May 29, 1958, with the expectation that bilateral adrenalectomy would be performed since adrenal cortical hyperplasia seemed the most likely diagnosis. The preoperative steroid preparation based on Thorn's recommendation [4] consisted of 100 mg. of cortisone administered intramuscularly twelve hours and two hours before surgery. This was supplemented during surgery with 150 mg. of hydrocortisone, administered, intravenously, in a 1,000 cc. of 5 per cent glucose water given during the operation. This dosage was repeated in six hours. A curving transverse upper abdominal incision was made, and on opening the abdomen, no ascitic fluid was noted. The liver was enlarged 2 fingerbreadths beneath the costal margin, and the spleen was about twice its normal size. The left adrenal was approached first because of the roentgenologic evidence of enlargement and the possibility of an adenoma. An incision was made in the posterior portion of the splenorenal ligament, and the spleen drawn downward and medially. Gerota's fascia was incised, and the left adrenal gland was exposed [5]. It appeared hyperplastic and about twice normal size. Examination by the pathologist revealed no adenoma. The right adrenal was approached next after dividing dense adhesions attached to an atrophic gallbladder which had evidently been the site of an acute inflammation. An incision was then made in the peritoneum upward from the superior margin of the duodenum parallel to the vena cava toward the caudate lobe of the liver. Inferiorly, the incision was carried outward, and the flap thus created was lifted forward and outward exposing Gerota's fascia which was incised superiorly and the adrenal exposed. The right adrenal gland appeared similar to the left and was about twice its normal size. It was removed totally. The patient's postoperative course was remarkably smooth despite his poor condition preoperatively.

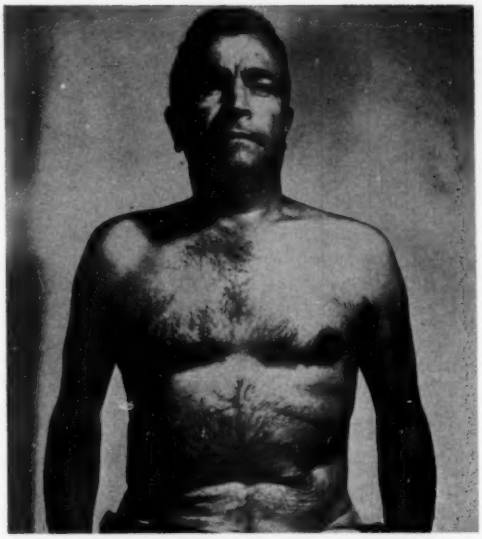

FIG. 5. View five months postoperatively. Normal body configuration has returned, truncal and facial obesity have disappeared, abdominal striae are almost obliterated.

The postoperative cortisone dosage followed Thorn's schedule and consisted of 50 mg. of hydrocortisone administered intramuscularly every six hours on the first day and every eight hours on the second and third days. From the fourth through the seventh day, 50 mg. of cortisone was given orally every twelve hours. Very gradually, over the course of the next three months, the daily dosage of cortisone was reduced to a maintenance dose of 30 mg. The level of cortisone dosage was controlled by the patient's sense of well-being, blood pressure, serum electrolytes and level of urinary salt excretion. Desoxycorticosterone (DOCA) was not found necessary during the six months that the patient has been followed up postoperatively. This is in keeping with our experience in the maintenance of several patients with Addison's disease in the past few years who have done very well on cortisone without the use of DOCA.

The left adrenal weighed 10 gm., and the right adrenal weighed 11 gm. These weights are approximately twice normal. On microscopic section, the glands were histologically normal. The zones in the cortex retained their normal relative proportions. The pathologic diagnosis was hyperplasia of the adrenals.

After surgery, the patient's edema of the legs and sacrum disappeared during a period of three weeks. His weight dropped to a low of 136 pounds, and at the time of discharge, it was 144 pounds. The

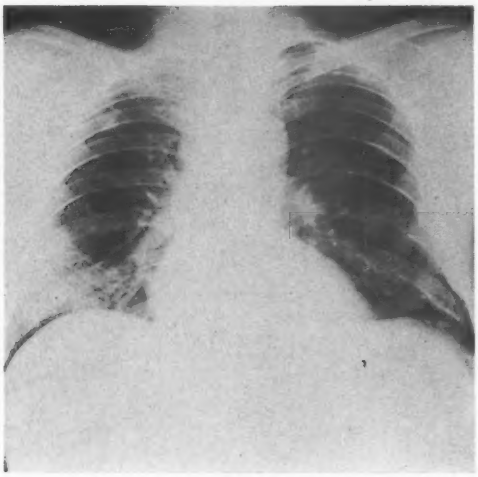

FIG. 6. The chest roentgenogram taken on October 20, 1958 shows a normal-sized heart, clear lung fields and disappearance of the rib deformity.

buffalo hump and moonface disappeared as did the abdominal obesity and striae, and the patient's facial contour and body outline returned to what it was before his illness. (Fig. 5.) The heart size returned to normal (Fig. 6), and his urine became free of albumin and sugar. The blood pressure, which was 180/130 mm. Hg just prior to surgery, fell to normotensive levels about four weeks postoperatively, and at the time of discharge on November 6 was 120/80 mm. Hg. Digoxin therapy was discontinued on June 27, 1958. The electrocardiogram was borderline at the time of discharge showing almost complete reversal of the preoperative abnormalities. (Fig. 7.) Serum electrolyte values returned to normal, and the alkaline phosphatase level was 6.3 Bodansky units. The bilirubin level became normal, and a battery of liver function tests were normal. The hematocrit values postoperatively were low ranging from 35 to 38 per cent. A bone marrow study was normal, and no evidence of hemolysis could be elicited. Coombs' test was negative, and urinary and fecal urobilinogen were normal. At the time of discharge, the left leg was completely healed. The previously described unhealed fractures of the pelvis were completely healed as were the fractured ribs. Before discharge, the patient had been on several leaves of absence from the hospital and did well. The necessity for the lifetime use of cortisone was explained to the patient as well as the necessity of increased doses of hormone in times of stress, and a wallet card describing his condition was issued to him.

COMMENTS

Histologically, the adrenal cortex is divided into three zones: (1) the zona glomerulosa, (2) zona fasciculata, and (3) zona reticularis. Each zone appears to have a distinct physiologic function. The clinical picture produced in the various syndromes of hypercortical function depends upon which cortical zone is predominantly concerned. The zona glomerulosa is considered the site of production of aldosterone, the hormone responsible for the regulation of

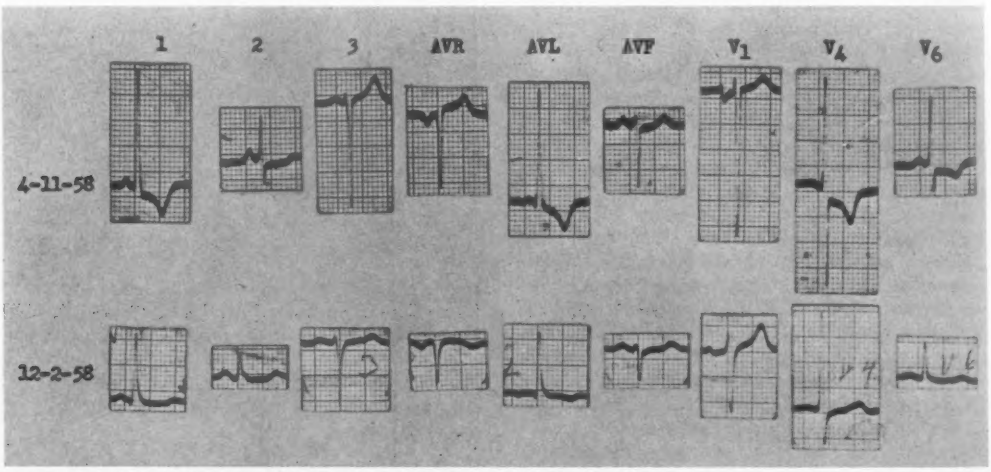

FIG. 7. The electrocardiogram of April 11, 1958 shows a marked left ventricular hypertrophy pattern. The electrocardiogram of December 2, 1958 shows return to normal pattern with reversal of the marked T wave inversions in leads 1 and V_4 and V_6. There is also marked decrease in amplitude.

sodium and potassium levels. Primary hyperaldosteronism, first described by Conn in 1953 [6], is characterized by high serum sodium levels, low potassium, elevated CO_2 combining power, hypertension and periodic weakness or paralysis. Aldosterone has a salt-retaining potency some thirty times greater than DOCA. The zona reticularis is the site of production of the 17-ketosteroids or androgen-like hormones, and overproduction of these hormones results in masculinization and the adrenogenital syndrome. The zona fasciculata is considered the source of production of the 17-hydroxycorticoids or glucocortocoids, the principal members of which are hydrocortisone and cortisone. These hormones have a profound effect on the intermediary metabolism of carbohydrates and more indirectly, protein and fats. Moreover, they have some hypertensive salt-retaining and potassium-excreting properties. Some of their excretion products are of the 17-ketosteroid variety. It is estimated that in the normal person, the daily turnover of hydrocortisone is about 22 mg. with a range from 17 to 29 mg. [7]. These hormones have an anti-insulin effect, decreasing the peripheral utilization of glucose, and they also have a considerable protein catabolic effect. Their effects on the depression of the antigen-antibody relationships and anti-inflammatory effects are well known. Cushing's syndrome is primarily due to an overproduction of glucocorticoids, and the iatrogenic production of Cushing's syndrome by steroid medication has become a fairly common occurrence. The clinical picture of Cushing's syndrome classically includes: (1) obesity of the face (moonface), neck and trunk, with an interscapular fat pad, (2) arterial hypertension, (3) a plethoric appearance, (4) muscular atrophy and weakness, (5) pigmented abdominal striae, (6) sexual disturbances (amenorrhea in the female, impotence in the male), (7) osteoporosis, (8) impaired glucose tolerance or frank diabetes, (9) impaired resistance to infection, (10) eosinopenia and lymphopenia, and (11) psychiatric abnormalities. All of these were exhibited by our patient. In addition, he demonstrated an elevated serum sodium level and a low potassium level, also an elevated CO_2 combining power. The prominence of hypertension to the point of hypertensive heart disease with congestive failure and electrolyte disturbances would indicate probable involvement not only of the zona fasciculata and glucocorticoid excess, but also of the zona glomerulosa and overproduction of aldosterone. The decreased glucose tolerance, osteoporosis, impaired resistance to infection, psychiatric changes and weakness are responses to excess glucocorticoids. The patient has suffered from hypercorticism for about five years, and at this time, sixteen months after total adrenalectomy, the changes due to excess steroid secretions have been reversed.

SUMMARY

The presenting complaint of this patient with Cushing's syndrome was a very severe infection of the leg. Hypertension, cardiomegaly, osteoporosis, impaired glucose tolerance, electrolyte disturbances and the physical appearance of the syndrome have been reversed following total adrenalectomy.

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Epidermoid Cyst of the Spleen

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EPIDERMOID cysts make up only a small proportion of that uncommon entity, the non-parasitic splenic cyst. Fowler [1], in his review of cases reported up to May 1952, noted that only twenty-three of the 265 cases of non-parasitic splenic cysts he had collected from the literature concerned epidermoid cysts. Lee and Arnspiger [2] mentioned four published cases of epidermoid cysts in addition to their own, bringing the total to twenty-eight reported cases.

Popular reference books on general and surgical pathology deal briefly with splenic cysts, most of them stating only that they are rare. Splenic cysts are classified as true cysts if they have a definitive cellular lining and as false cysts if they lack such a lining. Although true cysts may be congenital, traumatic or inflammatory in origin, the complex epithelium of the epidermoid cyst almost certainly indicates a congenital origin. Apparently Fowler [1] has established the most widely accepted criteria of the true epidermoid cyst. He believes that the presence of a stratified squamous epithelium containing prickle cells with visible intercellular bridges and an absence of keratinization are necessary for the diagnosis; however, he is inconsistent concerning the last point.

CASE REPORT

Case reports of all types rarely reflect the doubts, shifting viewpoints, differences of opinion and pursuit of false leads which often characterize the work-up of complex cases. Taken at face value, the course of most reported cases would seen to be an unwavering straight line. Although the case reported herein was not a complicated one, it followed an interestingly devious course until "the moment of truth" at the operating table.

During a required physical examination before the opening of school in September 1958, a twelve year old boy was found to have a slightly enlarged spleen by his family physician. The child was active and entirely free of symptoms. Rapid enlargement of the organ occurred and the family physician advised splenectomy. Another medical opinion was sought early in November 1958. At this time a large mass was visible as well as palpable in the left upper portion of the abdomen. The mass extended about 1 cm. past the midline toward the right and downward almost to the level of the anterosuperior spine of the ilium; the mass was non-tender, with smooth easily definable edges. Still, the boy had no symptoms except vague discomfort in the left upper portion of the abdomen and slightly decreased activity. Despite repeated questioning, no history of recent trauma could be obtained; the child had been struck on the left side of the abdomen with a piece of pipe about four years previously, but only slight tenderness lasting a few days had resulted. A physician was not consulted.

Initially, it was believed that the abdominal mass was almost certainly an enlarged spleen. Leukemia, Hodgkin's disease and congestive splenomegaly were considered the likeliest causes of the enlargement; a tumor of the kidney was listed as a fourth probability. Peripheral blood studies showed no deviation from normal values. A barium swallow test was ordered to detect the possible presence of esophageal varices and thus support or eliminate portal obstruction as the cause of the splenomegaly. Now the first doubts concerning the identity of the mass were introduced. The report read: "There is no evidence of intrinsic pathology of the esophagus. The stomach is markedly displaced to the left and anteriorly by a large left retroperitoneal mass, probably a left renal mass."

To pursue this lead further, an excretory urogram was taken a few days later. The resulting roentgenogram appeared to strengthen the new suspicion that this was a renal mass. The report read: "The preliminary abdominal film shows a large soft tissue mass in the left upper quadrant, displacing the stomach to the right and anteriorly. The excretory urogram shows a normal right kidney. On the left the kidney is enlarged and displaced laterally and cranially. The renal pelvis does not fill and the calyces are ill-defined, show separation and distortion, and do not fill well. The left ureter is seen in its

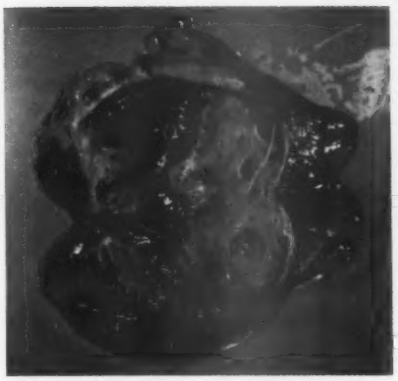

FIG. 1. The opened splenic cyst. The lining is shiny and trabeculated.

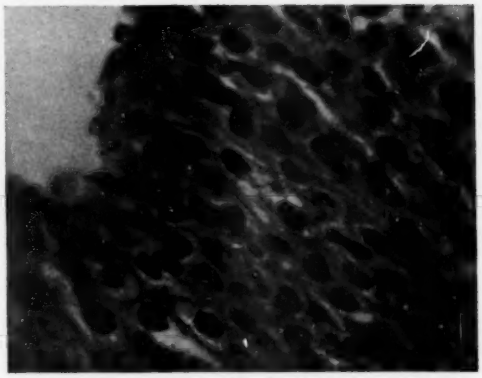

FIG. 2. A portion of a microscopic section of the cyst wall showing the stratified squamous epithelium.

proximal half and is displaced laterally. The large soft tissue mass surrounds the renal shadow with a sharply outlined lower border at the level of L-4. Impression: suspect malignant tumor, left kidney."

Although the shadow of the lower pole of the left kidney could be seen superimposed on the mass, it was thought that this was not incompatible with a tumor arising from the upper pole and extending inferiorly in front of or behind the kidney. Pressure by an extrinsic mass deforming the kidney was considered. Reference-book descriptions of embryomas and similar renal tumors did not mention the possibility of external compression producing a similar deformity on an excretory urogram. With seeming evidence of a left renal tumor on the x-ray studies, the diagnosis of splenomegaly was given second place to a renal tumor.

It was thought that further studies would contribute little and delay surgery needlessly. Therefore, on November 13, 1958, celiotomy was performed with a presumptive diagnosis of embryoma of the left kidney. When the abdomen was opened through a long left paramedian incision, a large, smooth, tense, purplish spleen immediately was apparent. A globular cystic mass occupied the hilum; thin, yellow fibrinous patches covered the anterior surface of the hilar area. The left kidney was palpated and found to be somewhat flattened and elongated but otherwise normal. Splenectomy was performed without difficulty, the organ being removed intact. The boy recovered uneventfully and was discharged from the hospital on the sixth postoperative day. An excretory urogram taken two months after surgery showed the left kidney to be normal in position and configuration.

The pathologic report was as follows: The spleen measured 19 by 13 by 11 cm., weighed 1,418 gm. and contained 600 ml. of dark, reddish brown, nonclotting liquid. After being opened, the cyst measured 10 cm. in diameter and its lining was shiny, trabeculated and gray-white in color. (Fig. 1.) Thickness of the cyst wall varied from a fraction of a millimeter to 2 mm.; the compressed splenic pulp ranged in thickness from 0.5 cm. to 2.5 cm.

Microscopic sections showed that the follicles were well preserved, with distinct germinal centers. The cyst was lined by squamous epithelium ranging from two to three cells in thickness in some areas to fifteen to twenty cells in other areas. (Fig. 2.) No surface keratinization was found. The lining cells were well differentiated and occasionally showed distinct intercellular bridges. A distinct basement membrane was found in all sections; an underlying thick fibrous layer of connective tissue was present outside the epithelium. The structure of the cyst lining supported a diagnosis of epidermoid cyst of the spleen.

SUMMARY

The report presented herein concerns an epidermoid cyst of the spleen in a twelve year old boy. The original diagnosis of splenomegaly was placed in doubt by x-ray studies which showed distortion of the left kidney. The cause of the rapid, asymptomatic enlargement of the spleen can only be guessed; hemorrhage into the cyst seems a reasonable explanation. The microscopic structure of the cyst wall fulfills the established criteria for that rarity, an epidermoid cyst of the spleen.

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Ureteral Metastasis Secondary to Carcinoma of the Large Bowel

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METASTATIC carcinoma to the ureter is a relatively rare entity, as noted by McCrea and Peale [1] in their survey of the world literature in 1951. Despite this fact we have encountered ureteral metastasis, secondary to gastrointestinal neoplasm, twice within a period of one and a half years. In February 1957 we found a case of ureteral carcinoma which had metastasized from the stomach [2]. Again, in September 1958, we encountered a metastatic ureteral lesion, with a neoplasm of the large bowel as the primary site. Because of our experiences we wish to bring to the attention of all physicians and surgeons the possibility of metastatic disease of the ureter in the differential diagnosis of causes of hematuria and hydronephrosis in patients with gastrointestinal neoplasms.

As Pressman and Ehrlich [3] have pointed out, hematuria occurs in only about 16 per cent of patients with metastatic ureteral carcinoma. This relatively low figure is due to the fact that ulceration of the ureteral mucosa is infrequent, and the malignant cells are found principally in the deeper layers of the ureter. They found that 70 per cent of patients had hydroureter and hydronephrosis due to encroachment of the lesion on the ureteral lumen. In 60 per cent of patients they found that there were metastases to both ureters, and in 90 per cent there were also metastases to other organs. Metastases were found at all levels of the ureter, with no one portion being predominately involved. The lesions could be seen or felt grossly in 86 per cent of patients. In the others there was microscopic infiltration with no significant encroachment on the ureteral lumen.

Mirabile and Spillane [4] have expressed the opinion that in these lesions the adventitial layer is first invaded, and there is subsequent spread into the muscularis and tunica propria by direct extension or along vascular channels. Later, attenuation or ulceration of the mucosa might occur.

A survey of the literature reveals only a few reports of ureteral metastasis secondary to neoplasms of the large bowel. McCrea and Peale [1] found only two such cases in their survey. One of these cases was reported by Jeck [5] in 1936. His patient had a history of bloody stools and a 90 pound weight loss over a six-month period. The patient became anuric and required emergency nephrostomy on one side and ureterostomy on the other. Death occurred six hours after operation. Postmortem examination revealed carcinoma of the sigmoid with metastases to the liver and both ureters. Each ureter had a metastatic lesion 7 cm. long and 3.5 cm. in its widest diameter. The other case was reported by Kleiman [6] in 1947. His patient was a twenty-one year old man who had undergone previous resection of the colon for adenocarcinoma of the descending colon. Subsequently symptoms consistent with renal colic developed. After appropriate studies, operation was performed, with the finding of a grape-sized metastatic adenocarcinoma to the ureter. Nephroureterectomy was performed, and the patient was alive nine months later.

The only other instance of metastatic carcinoma from the large bowel to the ureter found in the literature was reported by Klinger [7]. He made a study of 5,000 autopsies at Henry Ford Hospital in 1951 and found seven cases of ureteral metastasis. One of these cases was secondary to a neoplasm of the rectosigmoid.

CASE REPORT

A. K., a fifty-nine year old white woman with diabetes, was admitted to the hospital on September 1, 1958, with a history of generalized skin erup-

FIG. 1. Right retrograde pyelography. Marked right ureteral obstruction with filling defects of ureter visible, and evidence of hydroureter and hydronephrosis.

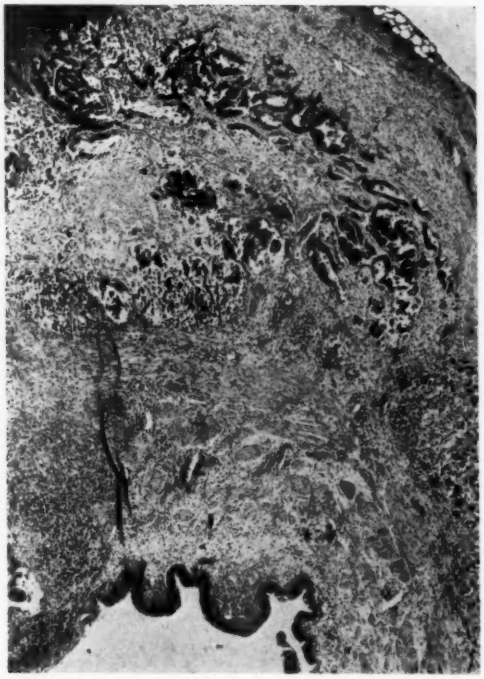

FIG. 2. Low power microscopic view of ureter with metastatic area from large bowel.

tion, nausea and vomiting of two days' duration. Four months prior to this admission a diverting colostomy had been performed because of an obstructing neoplasm of the rectosigmoid. Two and a half months later resection of the neoplasm was performed with primary anastomosis. (Local lymph nodes, positive for carcinoma, were also removed at this time.) She was discharged and booked for re-entry to the hospital later in September for closure of the colostomy.

For the few weeks after her discharge she had intermittent temperature elevation to 102°F., with chills. She also had frequency of urination and some urinary retention. Her urine was found to contain 4 plus albumin and many white blood cells with some clumps; non-protein nitrogen was 45 mg. per cent. She was given novobiocin by her physician. Within twenty-four hours a pruritic skin eruption developed. She was given antihistamines and cortisone but did not improve. She was then readmitted to the hospital for evaluation. On admission she was somewhat drowsy, and had an erythematous maculopapular eruption over her entire body. Abdominal examination revealed a functioning colostomy in the right upper quadrant. Rectal examination revealed tender, hard, nodular, indurated areas posteriorly.

On admission, hemoglobin was 9.9 gm. per cent. White blood cell count was 26,400 per cu. mm. Blood sugar was 218 mg. per cent. Urinalysis showed 4 plus albumin. Microscopic examination of the urine demonstrated many white blood cells with clumps. Blood urea nitrogen was 27 mg. per cent.

Barium enema revealed a short sinus tract leading into an abscess cavity in the hollow of the sacrum. It showed also that there was some narrowing of the upper part of the rectum and sigmoid. Biopsy of the rectal mucosa was performed, and the pathologic report gave the diagnosis of adenocarcinoma. Incision and drainage of the presacral abscess was performed, and a catheter was left in this area and brought out to the skin to allow optimum drainage.

Her postoperative course was complicated by several episodes of insulin reaction, during which her blood sugar was found to be as low as 55 mg. per cent. She had further difficulty voiding. A Foley catheter was inserted and left indwelling. She continued to have daily temperature elevation, and an intravenous pyelogram was performed. It showed no evidence of function of the right kidney. There was evidence of decreased function on the left with hydronephrosis and hydroureter. The following day a right retrograde pyelogram was performed, showing marked ureteral distortion. (Fig. 1.) Two days later, September 19, 1958, operation was performed.

Because of the findings of high ureteral obstruction on the right and low ureteral obstruction on the left, the preoperative plan was to perform ureterostomy on the left and either nephrostomy or nephrectomy on the right. The right kidney and ureter were explored first through an incision in the right flank. The ureter was found to contain intrinsic nodular masses. Frozen section was taken, and the report was metastatic adenocarcinoma. Indigo carmine given intravenously did not appear from the right kidney in over forty minutes. It was believed that nephrectomy was advisable, and this was performed without incident. Left ureterostomy *in situ* was then performed.

The pathologist's final report of tissue submitted was: metastatic adenocarcinoma of the right ureter (Fig. 2); acute and chronic pyelonephritis, right, with abscess formation; chronic perinephritis; right hydronephritis; intercapillary glomerulosclerosis.

The patient did fairly well immediately following surgery. Blood urea nitrogen remained at 27 mg. per cent. There was some hyponatremia, but otherwise the electrolyte studies were not markedly altered. Her ureterostomy output varied from 650 cc. to 1,375 cc. daily until the fifth postoperative day. Hypotension and oliguria then developed, and the patient began a rapid downhill course. Blood urea nitrogen rose to 42 mg. per cent. She died on the seventh postoperative day. Permission for postmortem examination was unfortunately not obtained.

SUMMARY AND CONCLUSIONS

A case of ureteral metastases secondary to a neoplasm of the large bowel is described partly because of its relative rarity, but primarily in order to call the attention of all physicians to this possibility in the evaluation of symptoms of the urinary tract in any patient with gastrointestinal or other malignancy. Since most such patients have multiple metastases, the prognosis must always be poor. Our patient lived for only one week after operation. The remaining kidney undoubtedly had changes due to intercapillary glomerulosclerosis plus hydronephrosis and pyelonephritis, and was incapable of the demands placed on it to maintain life. Severe diabetes added to the difficulties in the losing struggle.

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Localized Hodgkin's Disease of the Small Intestine

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This case is reported because of the rarity of the lesion and the interesting manner in which it was discovered.

A review of the literature reveals the scarcity of cases of localized intestinal Hodgkin's disease [1–4], and reports the general and local symptoms of some of the patients with this disease.

When one is confronted with a patient who has abdominal pain; nausea and vomiting; a history of alternating bouts of constipation and diarrhea; gross or occult blood in the stool; and evidence of small bowel obstruction, perforation or fistula formation; then the diagnosis may be suspected, and perhaps be confirmed during laparotomy [1].

The prognosis of patients with this disease varies with the extent of the original lesion, the presence of constitutional symptoms, the duration of the first remission, and whether or not total extirpation of the lesion was possible. Cases have been reported in which patients have remained clinically free of the disease for as long as twenty-five years, only to have a relapse and finally die of this disease. The possibility of a cure in some cases of localized visceral tumors of this group has been suggested [1,2,4].

CASE REPORT

W. R., a well developed forty-two year old Negro man, entered Michael Reese Hospital on February 1, 1957, with complaints of intermittent, colicky abdominal pain, nausea and vomiting, and occasional tenderness in the right upper quadrant of the abdomen that was initiated or became worse within thirty minutes after eating. These symptoms had been present for a week, but had become more severe in the past twenty-four hours. He had had a similar transient episode two months previously.

His past history included an appendectomy performed twenty years ago, and was otherwise within normal limits.

On physical examination, the blood pressure was 110/60 mm. Hg; pulse, 76 per minute; and temperature, 100°F. rectally. The ears, nose and throat appeared normal. The neck had a few shotty nodes along the carotid chain, but all were less than 5 mm. in diameter. The lungs were clear, and other than a soft grade murmur at the apex, the heart was normal. The abdomen was moderately distended, and was very tender in the right upper quadrant and near the umbilicus, with rebound tenderness present. The liver, kidneys and spleen were not palpated, nor were there other palpable masses. An old, well healed, oblique, surgical scar was present on the right lower quadrant. Bowel sounds were diminished and of distant quality. Rectal examination revealed soft, brown stool, normal prostate and no masses.

Laboratory examination revealed a white blood count of 7,800 per cu. mm. with a normal differential and a hemoglobin of 15.4 gr. Urinalysis was negative for albumin, reducing substances and acetone, and had a normal microscopic appearance. The Kahn test was positive, 2 plus. Serum bilirubin and amylase were within normal limits. Urine bilirubin and urobilinogen were present in trace amounts.

In the hospital, the patient continued to have colicky abdominal pain and vomited large quantities of bile-stained fluid. The abdominal tenderness became more severe and remained localized in the right upper quadrant and periumbilical areas. High pitched bowel sounds were noted, occurring in rushes corresponding with bouts of colicky pain. Abdominal x-ray examination with the patient supine and upright showed distended multiple loops of small intestine with air-fluid levels. Some gas was present in the large bowel.

Laparotomy was performed on February 4, 1957, with a preoperative diagnosis of mechanical small bowel obstruction. The abdomen was opened through a right paramedian incision with its midpoint at the level of the umbilicus. On opening the peritoneum, a thin yellow-tinged fluid and many loops of dilated small bowel were seen. On tracing the bowel down to the cecum, the point of obstruction was located at the last 3 inches of ileum, where the parietal peritoneum was firmly adherent to the

FIG. 1. Segment of ileum showing tumor (from which section has been cut) in the center.

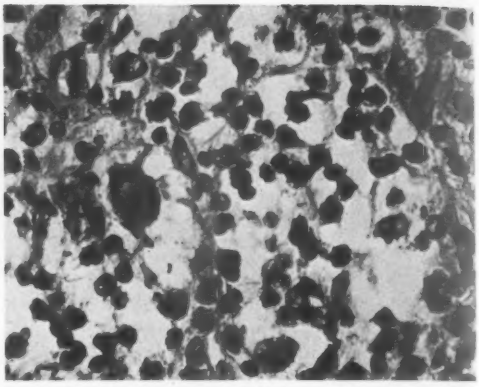

FIG. 2. Photomicrograph (original magnification × 600) of section through tumor showing Dorothy Reed cell, reticulum fibers, eosinophils, mitotic figures and pleomorphism.

ileum by adhesions. The entire small bowel was distended but viable, from the ileum to a point 4 inches below the ligament of Treitz. In tracing the bowel, a firm, rubbery tumor, 1 inch in diameter, disc-like, with an ulcer on the serosal surface was palpated 24 inches proximal to the ileocecal valve. There were many enlarged soft lymph nodes in the adjacent mesentery.

The adhesions were released and peristaltic waves were seen moving the ileal contents into the cecum. The tumor was then reinspected. Although it was not the obstructing mechanism, the tumor was resected and end-to-end anastomosis was performed because of the clinical suspicion of malignancy and the likelihood of reobstruction at the site of the neoplasm. A segment of ileum about 26 inches long with its mesentery was removed, with the tumor in the center of the specimen. All the lymph nodes present could not be removed.

Postoperatively, the patient was treated by intestinal decompression and parenteral fluids for four days, until he had stool per rectum and could tolerate the Kaslow tube clamped for several hours. The remainder of his hospital stay was uneventful, and he was discharged on the twelfth postoperative day. Postoperative chest roentgenograms did not indicate any enlarged mediastinal lymph nodes.

Grossly, the tumor was a slightly pedunculated, flat, round, polypoid, pinkish, hard mass measuring 3 cm. in diameter by 1 cm. in height. The surrounding mucosa was markedly edematous and hyperemic. (Fig. 1.) On section, the cut surface of the tumor was gray and homogeneous. It extended down to the serosal surface in its center. Elsewhere the mucosa appeared somewhat edematous but was otherwise normal. The attached mesentery contained numerous lymph nodes, the largest measuring 2 cm. in diameter. Microscopic examination of the lymph nodes showed only chronic follicular lymphadenitis.

Microscopically, the tumor was composed of large numbers of eosinophils, some reticulum cells, plasma cells, lymphocytes, and occasional giant cells of the Dorothy Reed type. Numerous mitotic figures were present. The covering mucosa was denuded and the tumor extended down to the muscularis externa. (Fig. 2.) The ends of the resected bowel were normal. Diagnosis was Hodgkin's disease of small intestine, involving largely submucosa and wall, with ulceration of mucosa.

Follow-up examination fifteen months postoperatively revealed no clinical or x-ray evidence of Hodgkin's disease. The patient has continued in his job involving hard labor and has been symptom free.

SUMMARY AND CONCLUSIONS

A case is reported in which a localized lesion of Hodgkin's disease of the ileum was discovered coincidentally during laparotomy for lysis of adhesions producing mechanical small bowel obstruction. Fifteen months following resection of the lesion, the patient exhibited no evidence of localized or systemic Hodgkin's disease.

It is possible that the disease has thus been fortuitously eradicated in this patient.

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Spontaneous Rupture of the Cervical Portion of the Thoracic Duct

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THE purpose of this paper is to report a spontaneous rupture of the cervical portion of the thoracic duct, and its spontaneous resolution. As far as I have been able to determine this is the first report of a case of this nature.

CASE REPORT

A fifty-four year old Negro woman entered the emergency room of Grant Hospital, Columbus, Ohio, on December 9, 1957, with a complaint of painless swelling of the left side of the neck of five hours' duration. Three days prior to the onset of her complaints she had undergone chiropractic manipulations of the cervical spine because of low backache. Three hours before the onset of swelling of the neck, at her noon meal, she had had an unexplained violent vomiting spell. Except for treatment by her physician for hypertension, her past history was otherwise non-contributory. She had no history of tuberculosis, previous surgery on the neck or any other condition which might conceivably cause adenopathy of the left side of the neck. There had been no chills or fever with the swelling and her only complaint was that of the deformity of the left side of the neck.

The initial examination showed a 2 plus pitting edema of the entire left side of the neck. There was no tenderness in this area and temperature was normal. Blood pressure in the left arm was 210/140 mm. Hg and in the right arm, 224/140 mm. Hg. Radial pulse was 100, normal bilaterally, and there was no discernible weakness in the left arm. No bruit could be heard in the neck. An x-ray film of the chest was normal except for "soft tissue swelling in the left side of the neck, either blood or lymph." Within twelve hours the pitting edema had spread laterally to the acromion and down over the upper half of the left breast. A 3 by 3 cm. non-tender mass was now palpable in the left subclavian triangle. The trachea was displaced to the right approximately 2 cm. The mass was aspirated and 3 cc. of a milky, watery fluid withdrawn. Hot packs were prescribed. Four days later the mass was larger, measuring 4 by 6 cm. and definitely cystic. No further aspirations were done and hot packs were continued. Surgical exploration was considered but within three weeks both the mass and the edema had completely subsided. The patient has remained well, with no recurrence twelve months later.

COMMENTS

I have been unable to find a similar report in the medical literature. Cases of chylous ascites and chylothorax are uncommon but well documented [3–7], and instances of traumatic fistulas of the cervical thoracic duct following surgery are likewise uncommon [1,2]. The staggering morbidity and mortality rates for untreated large fistulas of the lymph ducts is due to inanition and dehydration, 95 per cent of the lymph in the thoracic duct being derived from the intestines and liver [3].

Lampson's historic report [4] of traumatic chylothorax treated by ligation of the thoracic duct with survival has a point of similarity with this case. He was unable to ascribe a cause for the spontaneous occurrence of chylothorax in his patient other than a severe coughing spell. In the patient presented herein a vomiting episode is implicated. I believe the mechanism of injury here is the sudden intrathoracic pressure changes accompanied perhaps by the relative fixation of the left lymphaticovenous junction.

Judd and Nix [3] emphasize that spontaneously occurring lymphatic fistulas seldom close spontaneously because of the usual presence of underlying lymphatic disease. No lymphadenopathy was found in this patient following the subsidence of swelling.

Although laboratory confirmation of the

aspirated milky fluid was unfortunately not obtained, I believe it most closely conformed to the physical appearance of chyle, and could have been, in fact, little else.

SUMMARY

A case is presented of spontaneous rupture, and healing, of the cervical portion of the thoracic duct secondary to an episode of vigorous vomiting. No record of a similar case could be found in the literature. This case is believed to represent an unusual example of remote, spontaneous trauma which may occur following sudden changes in intrathoracic pressure.

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Massive Hemorrhage from Sigmoid Diverticula

THOMAS L. MEYER, M.D., *Columbus, Ohio*

From the Department of Surgery, Ohio State University Medical Center, Columbus, Ohio.

PATIENT O. P., an eighty year old white man, was admitted to University Hospital because of gross rectal bleeding. He had been brought from a nursing home to the Emergency Clinic where he passed grossly bloody stools in rapid succession.

According to the officials of the nursing home, he had been passing dark red blood rectally at frequent intervals for two days. The patient, pleasant but senile, denied pain but was unable to give an adequate history. He had been seen in the University Outpatient Clinic five years before because of low grade rectal bleeding. A complete work-up at that time, including upper and lower gastrointestinal studies and sigmoidoscopy, showed only diverticulosis of the sigmoid colon. He was to be followed up as an outpatient but did not return.

PHYSICAL EXAMINATION

The patient appeared somewhat restless but showed no evidence of shock. He was undernourished and moderately dehydrated. Blood pressure was 130/70 mm. Hg; pulse, 80 per minute; respirations, 18 per minute; and temperature, 98.6°F. His heart was somewhat enlarged and a grade II systolic murmur was heard over the entire precordium. The chest was clear. Abdominal examination was negative for abnormalities except for bilateral inguinal hernias which were easily reduced. Rectal examination showed only the presence of gross blood.

LABORATORY DATA

On admission, urinalysis disclosed a specific gravity of 1.018, a few white blood cells per high power field and was negative for acetone. Hemoglobin was 5.9 gm. per cent; hematocrit, 21.5 per cent; and white blood count, 4,300 per cu. mm. with a normal differential. Blood urea nitrogen was 39 mg. per cent; blood sugar, 83 mg. per cent; prothrombin time, 39 per cent; Bromsulphalein® retention, 0.9 per cent; serum electrolytes were within normal limits.

EARLY MANAGEMENT

The patient was immediately given whole blood transfusions and vitamin K parenterally, and information was recorded on a hemorrhage sheet. As soon as blood pressure and pulse were found to be stable, an emergency upper gastrointestinal series was performed. This was entirely negative for abnormalities. Sigmoidoscopy was negative to 10 cm. (visualization above this level was impeded by gross bleeding). Examination of the blood passed showed intact red cells. Because of the patient's past history of diverticulosis, a tentative diagnosis of bleeding sigmoid diverticula was made. Therefore, it was decided to defer surgery unless necessary to prevent exsanguination. The patient was given 2 gm. of neomycin orally every six hours and 15 cc. of Petrogalar® three times a day.

FURTHER COURSE

He continued to bleed massively for the first twenty-four hours and was given 5,500 cc. of whole blood. Pulse and blood pressure remained stable. In order to make a definite diagnosis, an emergency barium enema was attempted. This showed diverticula in the sigmoid but the entire colon could not be filled with the contrast media. Although this examination was not diagnostic, it was noted that immediately after-

ward the patient's bleeding diminished dramatically, stopping within the next six hours. He was given 1,500 cc. of whole blood, raising the hemoglobin to 10 gm. per cent. The patient continued to improve and on the third hospital day was started on a low residue diet and switched from neomycin to Sulfasuxidine,® 2 gm. every six hours. During the next ten days he received additional blood to elevate the hemoglobin to 13 gm. per cent. A subsequent barium enema showed marked diverticulitis of the sigmoid colon, and repeat sigmoidoscopy was negative up to 15 cm.

A regimen aimed at controlling the diverticulitis was planned. The patient was therefore discharged on a low residue diet, with instructions to take 2 gm. of Sulfasuxidine four times a day for seven days at the beginning of each month and one tablespoonful of mineral oil each day.

COMMENTS

The cause of the gross rectal hemorrhage in the patient reported on herein was diverticulitis of the sigmoid colon. The diagnosis was considered on admission because of his past history, but it was not seriously considered until an upper gastrointestinal series and sigmoidoscopy were negative for abnormalities. Although massive bleeding from diverticula of the colon is not infrequent, one should make every effort to rule out other causes of gastrointestinal bleeding before making the diagnosis.

The source of bleeding in diverticular disease of the colon cannot usually be identified by examination of resected specimens. However, Noer [3] has shown, by injecting the arteries and veins in specimens of the calonic wall with latex and then clearing, that a large number of vessels are contained in the walls of diverticula. It is easy to see how a severe hemorrhage might result if these vessels were eroded by an inflammatory process in these diverticula.

A decision for the conservative management of this patient was made because the bleeding, in the majority of these poor-risk patients, stops spontaneously on supportive therapy. Surgical correction of this malady is extensive and should be undertaken only when conservative measures fail. Although this patient required 5,500 cc. of blood during the first twenty-four hours, at no time was shock impending. Neomycin was given to treat the inflammatory process and also to sterilize the bowel should surgery become necessary.

Just how instrumental the barium enema was in stopping the hemorrhage is not definitely known. No authenticated reports showing this relationship are known to exist.

After bleeding ceased and the patient's overall condition improved, elective sigmoidal resection was considered. However, it was decided against because of the patient's age and the low incidence of recurrent massive hemorrhage from diverticulitis. The patient was discharged on a regimen designed to keep his stool soft and provide intermittent bowel sterilization, thereby attempting to prevent exacerbation of the diverticulitis.

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Solitary Pulmonary Nodules

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From the Department of Surgery, Thoracic Division, the Ohio State University Medical Center, Columbus, Ohio.

THE patient, a sixty-three year old white man, was admitted to the Ohio State University Medical Center because a lesion had been found in the right lung on a recent routine chest roentgenogram. He had noted weakness and increasing shortness of breath for the past three months, and had lost several pounds. Nine years prior to admission he had had an episode of productive coughing for three months followed by severe hemoptysis. Bronchograms were said to have shown bronchiectasis of the left lower lobe. He stopped smoking and had been asymptomatic until the onset of the present illness.

The past history indicated that two years prior to admission he had taken digitalis for four weeks for palpitation. He had occasional swelling of the ankles but took no medication for this.

PHYSICAL EXAMINATION

The patient was a well developed white male in no apparent distress. The temperature was 98°F., respiration rate 20 per minute, and blood pressure 140/64 mm. Hg. The pulse was irregular: the apical pulse rate was 110 per minute, while the radial pulse was 90 per minute. The breath sounds were clear except for coarse rales at the left base. There was a grade 3 apical systolic murmur. Minimal ankle edema was noted.

LABORATORY DATA

The hematocrit was 43.5 per cent; the white blood cell count was 8,450 per cu. mm. with a normal differential. The urine had a specific gravity of 1.021 but was otherwise normal. The blood urea nitrogen was 23 mg. per cent. Chest roentgenograms showed moderate cardiac enlargement. There was a 3 cm., slightly irregular parenchymal mass in the right lateral mid-lung field. An electrocardiogram showed atrial fibrillation but was otherwise normal.

EARLY MANAGEMENT

The patient was admitted with a diagnosis of probable carcinoma of the lung and mild congestive heart failure. The following special orders were written: (1) pulmonary function studies; (2) laminagraphy of the chest; (3) bronchography; (4) P.P.D. and histoplasmin skin tests; (5) 1.5 gm. sodium diet; (6) daily weighing and (7) medical consultation.

The pulmonary function studies showed a vital capacity of 117 per cent of normal and a three-second timed vital capacity of 85 per cent of normal. These indicated a moderate degree of emphysema and bronchial obstruction, and alerted us to possible pulmonary complications in the postoperative period. Laminagraphy was obtained to determine whether there was calcium in the lung mass and whether multiple nodules were present. Bronchograms were obtained because of the past history of bronchiectasis. The only changes noted were those of chronic bronchitis, which was more consistent with his relatively asymptomatic condition for the past nine years. A low sodium diet and daily weighings were ordered to follow the course of the congestive failure.

FURTHER COURSE

A medical consultation was obtained and a diagnosis of rheumatic heart disease with mitral insufficiency and atrial fibrillation was made. Because of the fibrillation and a questionable history of palpitation and chest pain two years prior to admission, the consultant suggested that the chest lesion might be an area of infarction. The patient was transferred to the medical service where he received digitalis and was given diuretics as indicated. Under this regimen he lost 7 pounds and the dyspnea was markedly relieved. However, after two weeks

of this regimen the chest mass showed no change, and he was transferred back to the surgical service for exploratory thoracotomy.

SURGERY

A right posterolateral skin incision was made and the chest opened through the fifth intercostal space. A 3 cm., firm, slightly nodular mass was located in the posterior segment of the right upper lobe. It involved the visceral pleura but not the parietal pleura. The entire nodule was removed by wedge resection over Carmalt clamps, taking care not to cut within 1 cm. of the mass. While waiting for the report on the frozen section, the defect was closed in two layers, using continuous No. 2-0 chromic catgut. The frozen section showed adenocarcinoma, and right upper lobectomy was performed with removal of hilar nodes and two nodes near the carina. The patient made an uneventful recovery. The final pathological diagnosis was adenocarcinoma of the lung with metastases to one hilar lymph node. No tumor was found in the mediastinal nodes.

COMMENTS

The reported incidence of malignancy in solitary nodules of the lung varies from 10 to 47 per cent. In the cases reported from Ohio State University Hospital, the incidence was 38.5 per cent [5]. The low rate of 10 per cent reported from Fitzsimmons Army Hospital was perhaps related to the preponderance of younger patients seen there. Among their patients over the age of fifty years, the incidence of malignancy was 47 per cent [3]. Davis et al. [1] have reported on a series of 215 patients with solitary pulmonary nodules in which no calcium was visualized in the x-rays. The incidence of malignancy was 47 per cent.

If calcium is present in large amounts or if the lesion appears laminated, the chances of malignancy are greatly reduced. However, small flecks of calcium do not indicate benignancy. In x-ray studies of 207 surgically removed nodules, O'Keefe et al. [2] found calcium in 50 per cent of the benign lesions and in 14 per cent of the malignant lesions. Laminagrams will often reveal calcium not seen in the routine films. Also, laminagraphy is useful in detecting multiple lesions or satellite lesions. This is of particular importance when a question of metastatic malignancy arises.

Generally 50 to 60 per cent of solitary pulmonary nodules are granulomas. Unfortunately, there is no reliable way to make a definite diagnosis short of thoracotomy. Bronchoscopy is not ordinarily indicated in the study of solitary pulmonary nodules inasmuch as these lesions are peripheral. Skin tests often give evidence of past or present infection with tuberculosis or histoplasmosis, but this does not necessarily mean that the lung lesion is benign. I believe that in the absence of lamination or a large central core of calcium, exploratory thoracotomy is mandatory. The mortality rate from surgery is lower (0.5 to 3 per cent) than from a conservative wait-and-see policy.

Although adenocarcinomas account for only about 20 per cent of bronchogenic carcinomas, they almost always arise in the periphery of the lung. Therefore, their incidence is considerably increased in malignant solitary pulmonary nodules, equalling the incidence of squamous cell carcinoma. Adenocarcinoma of the lung does not appear to be related to cigarette smoking.

Rigler [4] has shown that carcinomas of the lung may be visible on x-ray films for long periods of time, two to nine years, before causing symptoms.

Lobectomy is usually the procedure of choice for carcinomas presenting as solitary nodules. This is associated with a five-year survival rate of approximately 32 per cent. If all solitary nodules were to be removed while they are still small and asymptomatic, the survival rate could be further improved.

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Surgery Court Cases

HOWARD NEWCOMB MORSE,* *Atlanta, Georgia*

RICHISON VS. NUNN

Supreme Court of Washington

340 P. 2d 793

This was a surgical malpractice action brought by the patient against the surgeon. The Superior Court of Clark County, Washington, rendered judgment for the patient, and the surgeon appealed.

The patient alleged that the surgeon had negligently sutured a nerve into soft tissue adjacent to the surgical incision which he made for a hernia operation performed upon her. The patient also argued that the surgeon negligently failed to discover that he had so sutured the nerve into soft tissue. She further averred that the surgeon did not possess and use, in the performance of the hernia operation, the knowledge and care ordinarily and customarily possessed and used by surgeons in Vancouver and similar communities, in that he failed to locate the nerves in the area of the operation and failed to avoid suturing the nerve into the adjacent soft tissue and injuring the nerve.

The patient claimed that, by reason of the surgeon's conduct, she was caused to suffer excruciating and agonizing pain, of which the surgeon was promptly advised, and that the surgeon then and there failed and refused to make an examination to determine the cause of such pain. She contended that the surgeon refused daily to examine her to determine the cause of her excruciating pain but, on the contrary, required her to stand and walk and negligently failed to treat the injury and the resulting pain and suffering. As a result of the surgeon's negligence, she insisted that she had become permanently disabled.

The Supreme Court of Washington reversed the decision of the court below. The Surpreme Court found that in order to sustain a judgment against a physician or surgeon the standard of medical practice in the community must be shown, and, furthermore, that the doctor failed to follow the methods prescribed by that standard. The Court held that negligence on the part of the physician or surgeon by reason of his departure from the recognized standard of practice must be established by medical testimony. This was not done in the case, so the Court ruled that the patient could not recover.

KALIVES VS. BALTIMORE EYE, EAR AND THROAT HOSPITAL

Court of Appeals of Maryland

10 A. 2d 612

This was an action for wrongful death allegedly resulting from malpractice. There was an appeal from a judgment of the Superior Court of Baltimore, Maryland, in favor of the hospital, the surgeon, an anesthetist, an instrument nurse and a resident surgeon.

The patient arranged with a practicing surgeon of Baltimore for the removal of his tonsils and the turbinated bones of his nose. The patient and his family were assured that

* Counsellor at Law of the Supreme Court of the United States of America.

the contemplated operation was free from danger of any kind and that the patient would be able to return to his home in two or three days after the operation, a perfectly well man.

On the advice of the surgeon the patient entered the hospital at 9:45 A.M. where he was received, forthwith given anesthetics, and otherwise prepared for the operation which was performed between 2 and 5 P.M. on the same day. At the time fixed for the operation the surgeon, an anesthetist, an instrument nurse and a resident surgeon at the hospital caused the patient to be taken to the operating room, and there the surgeon, assisted by the resident surgeon, performed four major surgical operations on his nose and three on his throat. They packed the nose so tightly with compressed cotton that air could not pass in or out therefrom.

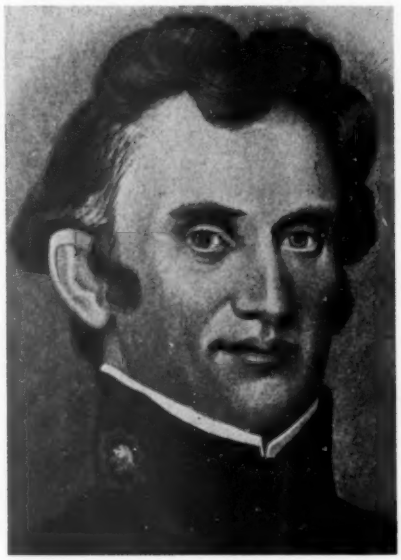
Ether was administered to the patient during the course of the operations, and an ether tube was left untied in the mouth of the patient when he was returned to his room in the hospital in an unconscious and helpless condition. The ether tube came out of place and position in which it was used to control the tongue, and "allowed the blood, serum and mucous to run down into the windpipe, clot, and stop the air from passing to the lungs." The patient was allowed to remain in a dark room unattended. At 7:30 P.M. he was found struggling and gasping for breath, the tube then being removed from his mouth. He died less than two hours later.

The Court of Appeals of Maryland affirmed the decision of the lower court. The Court of Appeals held that the evidence as to negligence on the part of the surgeon, the anesthetist, the instrument nurse and the resident surgeon was insufficient for the jury. The Court held that before recovery could be had, it must be shown by affirmative evidence that the foregoing individuals were either unskilled or negligent in their respective capacities, and that such want of skill or care resulted in the death of the patient. The Court ruled that if either of the aforementioned elements is lacking in the proof, then no case for the consideration of the jury has been presented. The Court declared, "The evidence adduced in the instant case points to no specific act of negligence on the part of any one of the several defendants."

Our Surgical Heritage

D. P. HALL, M.D., *Surgical Department, University of Louisville, Louisville, Kentucky*

UNITED STATES OF AMERICA



WILLIAM BEAUMONT

THE world of surgery and physiology owes a great debt to a once obscure Army surgeon, William Beaumont. He became America's first surgical physiologist, by a sequence of events which began on a fateful June day in 1822 when Alexis St. Martin, a French Canadian voyageur, was wounded in the pit of his stomach by a shotgun which was accidently discharged in front of the American Fur Company's store at Fort Mackinac.

Beaumont was born in Lebanon, Connecticut, in 1785. He received a good common school education, worked on a farm and was a regular church attendent. In 1806 he was employed as a village schoolmaster at Champlain, New York, near the Canadian border. He taught school for three years and decided on medicine as a career. He became an apprentice and student in the office of Dr. Benjamin Chandler at St. Albans, Vermont, where he remained for two years. After the completion of his apprenticeship, The Third Medical Society of the State of Vermont issued him a license for the practice of medicine in June 1812. During this month the United States of America declared war against England, and in September Beaumont joined the American Army as a surgeon.

During the Second War of Independence Beaumont kept a careful diary of his experiences. He described rather vividly the surgery of that period, " . . . the surgeons wading in blood, cutting off arms, legs, and trepanning heads." "Following the battle of Little York," he added, "I cut and slashed for forty-eight hours without food or sleep."

William Beaumont retired from the Army in 1815 and began the practice of medicine at Plattsburgh, New York, but after five years he

was commissioned as a Post Surgeon in the Army and reported to Fort Mackinac which was then on the Northwestern frontier of America.

At Fort Mackinac Beaumont received his opportunity for experimental physiology when Alexis St. Martin was wounded from a shotgun blast received in the pit of the stomach. Beaumont attended him, extracting shot and pieces of clothing, and dressing the wound.

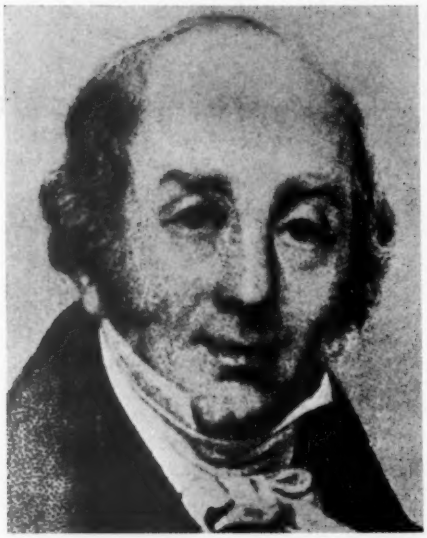
Alexis St. Martin recovered in two years but was left with a large fistula into his stomach. Beaumont carried out various experiments on the digestion of articles of food which he suspended through the fistula into the stomach by the aid of a string. He recovered gastric juice from the human stomach and used this to continue his experiments on gastric digestion. Because of his lack of knowledge of chemistry he obtained the assistance of Robley Dunglison, then Professor of Physiology at the University of Virginia, and Benjamin Silliman, at one time Professor of Chemistry at Yale University. It was Silliman who examined the gastric juice from St. Martin and reported "Its free acid is chiefly hydrochloric acid."

In 1833 Beaumont's notable book entitled "Experiments and Observations on the Gastric Juice and the Physiology of Digestion" was published. The same year Columbian College (George Washington University) awarded an M.D. degree to William Beaumont.

He resigned from the United States Army in 1839 and again resumed the practice of medicine, this time in St. Louis, Missouri. He died in 1853 and is buried in St. Louis.

All surgeons are grateful for the experiments of this obscure Army surgeon, William Beaumont.

EUROPE



ABRAHAM COLLES

On July 23, 1773, Abraham Colles was born at Millmount, Kilkenny, Ireland, where his family had lived for two generations. His grandfather was a medical man, and his father owned and operated an extensive quarry, producing the famous Kilkenny marble. Colles was the first in a noteworthy line of Irish medical men who had a profound influence and left a distinct record in surgery. He was the first of the group which was later to be known as the "Irish School."

Colles became a student at Trinity College, Dublin, and at this Institution received a Bachelor of Arts degree in 1795, the same year he obtained a diploma from the College of Surgeons of Ireland. He matriculated at the University of Edinburgh where he received an M.D. degree in 1797. Colles journeyed to London where he became an assistant to Sir Astley Cooper in the study of the anatomy of hernia. Colles was very insistent that anatomy should be the principal fundamental science in the training of a surgeon.

In 1799 Abraham Colles was elected resident surgeon at the Steevens Hospital in Dublin. He was appointed Professor of Anatomy and Surgery at the College of Surgeons, which appointment he held for thirty-two years. It was in this period that his contributions to surgery were of such magnitude that the reputation of the "Irish School" became firmly implanted in world medicine. He was recognized as the master surgeon in Ireland and one of surgery's great teachers.

Colles' writings had a profound influence on surgery at home and abroad. His "Treatise On Surgical Anatomy, Part I" was published in Dublin in 1811 and later reprinted in Philadelphia. Colles' fracture became a household word and has lived to the present day because of observations he published in the *Edinburgh Medical and Surgical Journal* in 1814 entitled "On Fracture of the Carpal Extremity of the Radius."

The year 1837 was made auspicious by the establishment of the Louisville Medical Institute and the publication of Colles' report on "Practical Observation on the Venereal Disease, and on the Use of Mercury." Colles observed that "a child born of a mother who is without any obvious venereal symptoms and shows this disease when it is a few weeks old will infect the most healthy nurse and yet this child is never known to infect its mother." Thus was born Colles' law.

This great surgeon, the first in line in the "Irish School," died in a deep painless sleep in 1843.

The Diagnostic Corner

An interesting case of recurrent acute abdominal disease in a middle-aged female.

SIDNEY W. NELSON, M.D., *Columbus, Ohio*

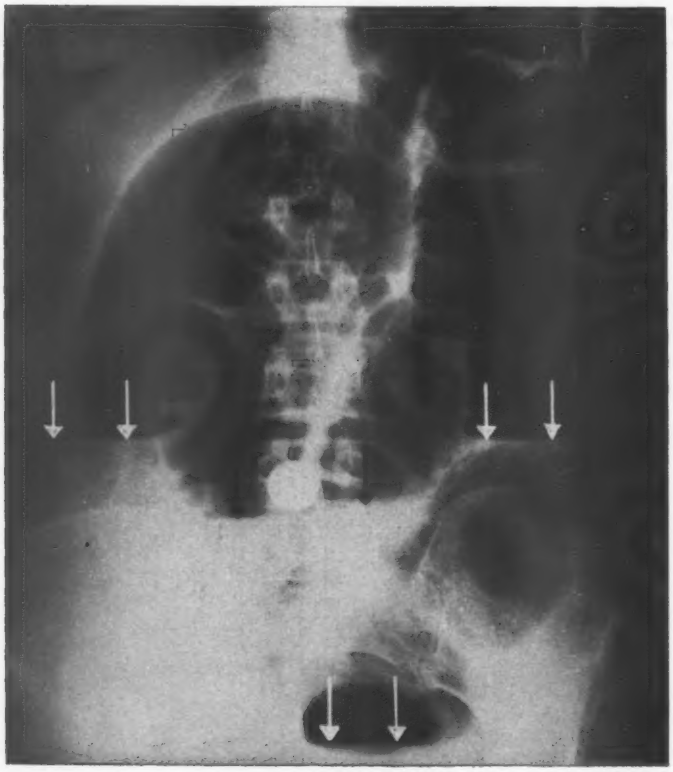
From the Department of Radiology, The Ohio State University, Columbus, Ohio.

THIS forty-four year old white woman had been in good health until four days prior to admission, at which time pain developed in the left lower quadrant and left upper quadrant. Soon it became a generalized abdominal cramping pain associated with nausea and vomiting. She had been unable to retain any type of ingesta except small amounts of liquids during the four days since the onset of the illness. The last bowel movement had been four days prior to admission. There had been no change in the caliber of the stools, bowel habits or appetite prior to the onset of the illness. The patient had noted no evidence of melena. She had had a previous similar episode which lasted for several days approximately six months prior to admission, but the illness had subsided spontaneously.

Physical examination at the time of admission showed a temperature of 98.6°F.; pulse rate was 102 per minute, respirations 120 per minute. The patient was a well developed, well nourished, somewhat dehydrated, slightly pale, white female in moderate distress. The abdomen was distended with markedly hyperactive audible bowel sounds with frequent peristaltic rushes, and palpable bowel loops in the suprapubic area. There was slight periumbilical tenderness. The serum sodium was 142 mEq./L. The serum potassium was 3.9 mEq./L. and the serum chloride 108 mEq./L. The CO_2 combining power was 55 vol. per cent. Other laboratory tests were within normal limits. No masses could be palpated. Supine and upright (opposite) films of the abdomen taken at the time of admission showed large dilated loops of gut. *What is your diagnosis?*

Please turn page for answer

Diagnosis: Mechanical obstruction of the rectosigmoid due to endometriosis.



The upright x-ray film showed marked distention of the colon with air-fluid levels (arrows, opposite). There was very little evidence of air and fluid in the small bowel due to the fact that the ileocecal valve was competent, thus preventing reflux of gas and fluid from the colon into the small bowel. These findings are classic for mechanical obstruction of the distal colon with a competent ileocecal valve.

The x-ray findings were certainly not indicative of endometriosis, although the disease must be considered as an etiologic mechanism for obstruction of the distal colon in premenopausal females. In general, the most common cause for obstructions of the distal colon are carcinoma and diverticulitis. It is important to recognize endometriosis when it is encountered at surgery, because much less radical surgery is indicated and the prognosis is very favorable. Endometrial implants can occur almost anywhere in the abdomen, although the most common sites are on the peritoneal surfaces of the organs of the lower abdomen. Endometriosis, which may cause severe symptomatology including rectal bleeding, tenesmus and obstruction of the colon, will regress after the onset of the menopause.

At surgery a large inflammatory mass, to which a large right ovary was adherent, was found in the cul-de-sac. The ovary contained a large chocolate cyst 4 cm. in diameter which comprised part of the mass in the cul-de-sac. Anterior resection of the left colon was performed, more radical surgery being avoided inasmuch as the lesion was not a malignant tumor. A Baker type of side-to-end anastomosis was performed. The patient made an uneventful recovery.

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Book Reviews

Lumbar Disc Lesions. By J. R. Armstrong, M.D., M.CH., F.R.C.S. Second edition, 242 pages. Williams & Wilkins Co. Baltimore, 1958. *Price* $12.00.

Mr. Armstrong's new edition, six years after publication of the original, follows basically the pattern of the first edition and measures up to the standards previously set. The 242 well illustrated pages with black and white and colored drawings and clear roentgenograms add much to simplify the often perplexing problem of lumbar disc lesions.

The first three chapters deal with the anatomy and function of the intervertebral disc and also a review of the shock-absorbing mechanism, water exchange and function of the annulus and nucleus. The early, normal development of the lumbar disc is presented with the suggestion that embryological abnormality may be an etiological factor in the formation of lower intervertebral protrusions.

Chapters IV and V review the pathology of the lumbar disc lesion. The author states that 40 per cent of patients with herniations give no history of trauma as a possible mechanism of protrusion. The local disc changes are classified in three stages: (1) softening and fragmentation of the nucleus and posterior annulus, (2) posterior displacement of part or all of the nucleus, and (3) fibrosis, decrease in size of the herniated nucleus and annulus with absorption and calcification.

The clinical picture (Chapters VI through IX) describe in detail the subjective and objective findings of lumbar disc lesions. The remainder of the book from Chapters X to XVII is concerned with the differential diagnosis, conservative and operative treatment. Mr. Armstrong's arguments on the unnecessary emphasis of leg traction in acute lumbar disc lesions will bring many a provocative debate as well as his advocation of a greater exposure (removal of the entire spinous process of L_5, exposure of the fourth lumbar lamina and part of the sacrum) for a fifth lumbar disc surgical approach.

The author's many readers will be pleased to crystallize their thoughts concerning the relationship between removal of a disc and arthrodesis. It warms my heart to read Mr. Armstrong's statement, "In the opinion of the author, arthrodesis of the affected joint cannot be justified as an immediate and routine measure in all patients operated on for a disc lesion."

The author does not profess to answer all the problems of lower lumbar disc lesions in his book, but his vast clinical experience, clarity and orderly approach contribute toward a better understanding of this difficult and at times little understood problem. I believe the resident and practicing orthopedic surgeon will welcome this book as part of his armamentarium.

PAUL S. DERIAN, M.D.

Neurological Basis of Behavior. Edited for the Ciba Foundation by G. E. W. Wolstenholme, O.B.E., M.A., M.B., B.CH. and Cecilia M. O'Connor, B.SC. 109 illustrations, 400 pages. Little, Brown & Co. Boston, 1958. *Price* $9.00.

This volume is another in a series of symposia which have been fostered by the Ciba Foundation of London, England, and contains the papers that were presented at a meeting in 1957.

The authors and discussants included such world renowned figures as Lord Adrian, Sir Russell Brain, Professor J. C. Eccles and Dr. Wilder G. Penfield.

The subjects presented were of wide variety and ranged from basic work on the nerve cell to complex human behavior, with studies of comparative neurophysiology, neural chemistry and the action of drugs on the nervous system.

At present, the relationship of these basic disciplines to human behavior is far from established but it is believed that such relationships must exist and that symposia such as this one will eventually place psychology and psychiatry on a neurological basis.

This is a book that should broaden the outlook of every student of human behavior.

DWIGHT M. PALMER, M.D.